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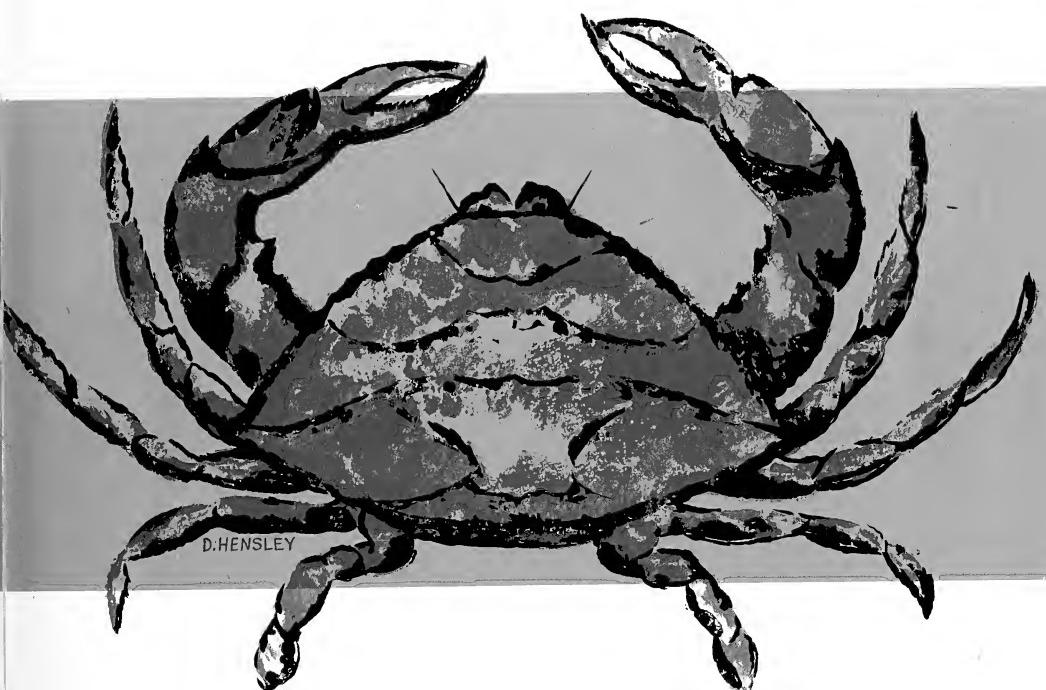
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WINTER
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Physiology of Aquatic Phycomycetes

I. Nutrition of *Phlyctochytrium* sp.*

Abstract—In general, carbohydrates function as a more readily available source of carbon than do amino acids, peptones, or proteins. The number of single amino acids that can supply nitrogen is restricted, and none was utilized as the sole source of both carbon and nitrogen. The amino acids used included members of the ornithine cycle. Peptones and proteins supported greater growth when the medium was supplemented with glucose. The only portion tested which was not substantially metabolized when offered with glucose was gelatin. Growth did not occur under anaerobic conditions nor did the organism produce lactic acid from glucose. This isolate does not diverge nutritionally from what is generally known about the nutrition of these organisms.

The chytrids are a ubiquitous group of aquatic and terrestrial fungi in which past studies have largely centered on their morphology and reproductive mechanisms. Little is known of their physiology, although a start has been made in studying the nutrition of these organisms. Definitive studies on the nutrition of members of the Chytridiales began with the publications of Stanier (1) and Ajello (2). Since then several reports have been forthcoming the most recent being those by Goldstein (3, 4, 5), Willoughby (6), Reisert and Fuller (7), and Murray and Lovett (8). Results of nutritional studies are important because they can be used to formulate media and techniques which will make it easier to isolate and cultivate these organisms and thereby encourage their study. Nutritional studies are also needed for a wider variety of chytrids before present concepts concerning their phylogeny can be confirmed. In addition to nutritional studies an examination of other facets of their lives must be carried out before we are to appreciate fully their contribution to the biotic community.

Materials and Methods

The organism used in this study was kindly supplied by Dr. W. W. Scott.² It is a monocentric,

eucarpic chytrid with a subsporangial apophysis and branched rhizoids. The sporangium is spherical and is from 20 μ to 100 μ in diameter. On the smaller sporangia the apophysis ranges from 6 μ to 12 μ , and rhizoids arise at several locations. The wall is smooth and exhibits 4 to 7 papillae through which the actively motile posteriorly uniflagellate zoospores emerge. The zoospores contain 1 or 2 refractile globules and average about 3 μ to 5 μ in diameter with a flagellum of about 20 μ .

Except in those instances noted below all chemicals were reagent-grade. The chitin, which was designated as "quite pure," was obtained from a non-commercial source in the 1950's and the supplier is now unknown. The two types of cellulose used were Whatman No. 1 filter paper, and dialysis tubing (regenerated cellulose). Casein was of "purified" quality, and gelatin and egg albumin were of C.P. grade. Casamino acids, casitone, and peptone were from Difco. The trypticase was from Baltimore Biological Company.

All growth studies were performed in a basal medium containing Ca (as CaCl_2), 1.20 mg%, Mn (as $\text{MnCl}_{1.4} \text{H}_2\text{O}$), 0.10 mg%, Zn (as $\text{ZnSO}_{4.6} \text{H}_2\text{O}$), 0.02 mg%, Co (as $\text{CoCl}_{2.6} \text{H}_2\text{O}$), 0.01 mg%, Mo (as $\text{Na}_2\text{MoO}_{4.2} \text{H}_2\text{O}$), 0.01 mg%, Cu (as $\text{CuSO}_{4.5} \text{H}_2\text{O}$), 0.001 mg%, Fe (as $\text{FeCl}_{3.6} \text{H}_2\text{O}$), 0.20 mg%, $\text{MgSO}_{4.7} \text{H}_2\text{O}$, 0.05%, KH_2PO_4 , 0.10%, and K_2HPO_4 , 0.10%.

Starch, glycogen, inulin, and dextrin were autoclaved as distilled water solutions and added aseptically to the basal medium. All other carbohydrates, urea broth (Difco), and the sodium salts of alpha-ketoglutarate, lactate, malate, and pyruvate were prepared in the mineral base and were sterilized by passage through a Millipore filter (0.45 μ), or Seitz filter in which the asbestos pads were washed with distilled water prior to sterilization. All other substrates were autoclaved in the basal medium. Glucose was also added to media as an autoclaved distilled water solution since it did not result in any significant change in the amount of growth. The final pH of all media was 6.7 and 40 ml was dispensed into 125 ml cotton-plugged Erlenmeyer flasks. Incubation was carried out for

* Part of this investigation is based on a portion of a dissertation submitted to the Graduate School of Lehigh University in partial fulfillment of the requirements for the degree of Doctor of Philosophy, and part was supported by Madison College.

¹ Revised, December 3, 1968.

² Head, Department of Botany, Eastern Illinois University, Charles-ton, Ill.

7–10 days at 27°C under static conditions. These conditions were used in all studies unless otherwise indicated.

Cells for the inoculum were grown in the basal medium supplemented with $(\text{NH}_4)_2\text{SO}_4$, 0.05% and glucose 0.2%. After six days incubation under the above conditions, the flasks were shaken to disperse the cells. The cells from 10 ml of this cell suspension were retrieved by centrifugation (1500 rpm), and were washed once with sterile basal salt solution. Resuspension of the cells in 10 ml of this salt solution constituted the inoculum, and two drops, approximately 0.1 ml, was inoculated into each growth flask. The ability of various substrates to support growth was evaluated in terms of cellular dry weight. Cells were prepared for drying by harvesting via centrifugation, followed by two distilled water washes. The cells were transferred to tared aluminum-foil dishes and placed in an oven at 70°C for 24 hours. Dry weight determinations were made with a Mettler H-6T balance, and are expressed as means of duplicate experiments. The average difference in dry weight between duplicate flasks was 1 mg with none exceeding 2 mg. All dry weight data reported in the tables have been corrected for controls.

The method used to determine gelatinase activity was that of Smith and Goodner (9). The basal medium contained neopeptone, (Difco), 0.4%, yeast extract, 0.1%, and agar, 1.5%. This medium was supplemented with 1.0, 3.0, and 5.0% gelatin and poured into plates. The plates were spot inoculated and incubated for 12 days.

Two methods were used to determine if this organism could grow under reduced oxygen tensions. In the first method the mineral base was supplemented with 0.05% $(\text{NH}_4)_2\text{SO}_4$ or KNO_3 and 0.5% glucose. Incubation was carried out in an anaerobic jar in which the air was replaced with nitrogen gas, (99.9% pure), by a process of alternately removing the gaseous phase with a vacuum pump and replacing it with nitrogen gas. After the third repetition of this process the jar was left under a slight nitrogen pressure so that if leakage occurred during incubation it would be detected upon opening the jar. The second method used the mineral base supplemented with 0.2% glucose and either 0.05% $(\text{NH}_4)_2\text{SO}_4$ or KNO_3 , or 0.2% Bacto-peptone in 125 ml glass stoppered bottles. After sterilization and inoculation the cotton plugs were removed, additional sterile medium was added to the brim of the bottle, and the sterile glass stoppers were twisted down tight to exclude air.

Lactic acid was determined by the method of Barker (10), using p-hydroxydiphenyl for color development.

Results

The ability of various carbohydrates to support growth is indicated in Table I. Of the polysaccharides used glycogen supported the greatest amount of growth. The slight increase in growth on soluble starch, as compared to potato and corn

TABLE I
Carbohydrates As Growth Substrates

Carbohydrate	0.20% $(\text{NH}_4)_2\text{SO}_4$	Dry Weight mg
	0.05%	
Inoculated control		1.3
Starch, soluble		17.5
Starch, potato		13.3
Starch, corn		11.8
Chitin*		0.0
Cellulose (dialysis tubing) ^a		0.0
Cellulose (filter paper) ^a		0.0
Glycogen (oyster)		29.2
Inulin		0.0
Dextrin		15.7
Raffinose		0.0
Maltose		6.9
Sucrose		0.0
Lactose		0.0
Cellobiose		21.9
Melibiose		0.0
Trehalose		10.8
Glucose		31.7
Galactose		3.5
Mannose		23.6
Fructose		23.2
Rhamnose		0.0
Arabinose		0.0
Xylose		0.0

* The chitin and cellulose substrates were incubated for 24 and 21 days respectively.

starch, is probably attributable to the partially depolymerized state of this substrate. Dextrin supported growth comparable to that with soluble starch. Even though *Phlyctochytrium* sp. showed several small localized areas of growth on dialysis tubing after three weeks incubation, it is not felt that this is sufficient evidence to categorize this chytrid as cellulolytic. Since there was no visible disintegration of the structural rigidity of the tubing, growth may have resulted because of impurities in the tubing itself. This reasoning is supported by the complete lack of utilization of filter paper shreds. Although cellulose was not readily attacked, cellobiose functioned very well as a growth substrate.

Of the monosaccharides examined glucose supported the best growth, with mannose and fructose the next most readily utilized sugars. The relatively limited growth on maltose by a chytrid which can use starch has also been reported by Crasemann (11) for a species of *Chytridium*. Pentose sugars, insofar as they were tested, were not available as sole sources of carbon for growth.

The availability of organic nitrogen in the form of amino acids is reported in Table II. The results indicate that the variety of amino acids which can support growth as the sole source of nitrogen is restricted. Of the monoaminodicarboxylic acids only aspartic acid allowed growth. The amide of this amino acid was more readily utilized, and even glutamine functioned as an available source of nitrogen, whereas the acid-form of this amino acid was totally unavailable. The slight growth on D-

TABLE II
Amino Acids As Growth Substrates

Amino Acid 100 mg N/L*	Dry Weight mg
Glucose 0.20%	
DL-Alanine	0.0
L-Arginine	26.1
L-Asparagine	25.8
L-Aspartic Acid	11.4
DL-Citrulline	8.1
L-Cysteine	23.3
L-Cysteic Acid	0.0
L-Glutamic Acid	0.0
L-Glutamine	16.6
Glycine	0.0
Hippuric Acid	0.0
L-Histidine	0.0
L-Hydroxyproline	0.0
DL-Leucine	0.0
DL-Lysine	0.0
DL-Methionine	0.0
DL-Norleucine	0.0
DL-Ornithine	20.1
DL-Phenylalanine	0.0
L-Proline	0.0
DL-Serine	0.0
DL-Threonine	0.0
L-Tryptophan	0.0
L-Tyrosine	0.0
DL-Valine	0.0
D-Alanine	0.0
D-Asparagine	4.0
D-Histidine	0.0
D-Tryptophan	0.0
D-Valine	0.0

* Nitrogen calculated on basis of L-form.

asparagine may be due to a lower rate of metabolism with this compound or to contamination of this substrate with small amounts of the L-form. Other amino acids that supported growth were arginine, cysteine, and two non-protein amino acids citrulline and ornithine. The neutral, aromatic, and heterocyclic amino acids were not able to furnish the sole source of nitrogen. The amino acids tested did not support growth when they were offered singly as the only source of both carbon and nitrogen.

The results of growth studies using proteins, peptones, and inorganic nitrogen compounds are reported in Table III. The data indicate that except for gelatin all proteins tested were utilized for growth. Since gelatin did not support growth the ability of this organism to produce gelatinase was checked by the plate method of Smith and Goodner. The medium containing 1.0% gelatin showed a clear zone 50 mm in diameter surrounding a colony of about 10 mm in diameter. Those plates incorporating 3.0% and 5.0% gelatin showed very slight clearing and the zones were less defined. It appears then that *Phlyctochytrium* sp. does possess a gelatinase; however, the ability to synthesize this enzyme is relatively weak. The complete lack of growth with 12.0% gelatin in the presence of 0.2% peptone, which itself supported slight growth, may have been due to the effects of in-

creased osmotic pressure resulting from the high concentration of protein. It should also be noted that the greatest growth response occurred when the protein or peptone media were supplemented with glucose. The lesser amounts of growth with protein and peptone alone was not due to an excessive rise in pH from the production of ammonia, as the pH of these cultures was between 6.7 and 7.0 when growth was measured.

The inability of *Phlyctochytrium* sp. to grow in 1.0% casamino acids, in the presence of glucose, probably reflects its sensitivity to the increased salt concentration provided by this acid-hydrolyzed substrate. The use of casamino acids at a 1.0% concentration concomitantly increases the sodium chloride level of the medium to 0.13% which may have been inhibitory. To determine if this were true the concentration of casamino acids was reduced to 0.2%, which had permitted growth, and sodium chloride was added to again give a salt concentration of 0.13%. The inhibitory action of the salt in this medium is shown in the data in Table III.

When various peptones were supplied at equivalent concentrations they supported essentially equal amounts of growth. The 0.06% peptone has roughly

TABLE III
Proteins, Peptones, and Inorganic Nitrogen
As Growth Substrates

Substrate	%	Dry Weight mg
Blood fibrin	1.0	2.3
with glucose	0.5	10.3
Cascin	0.5	12.8
with glucose	0.2	50.9
Egg albumin	0.5	19.2
with glucose	0.2	72.6
Gelatin	12.0	0.0
with peptone	0.2	0.0
Gelatin	1.0	0.0
with glucose	0.5	0.0
Gelatin	0.5	
with glucose	0.2	2.2
Casamino acids	0.2	7.8
Casitone	0.2	8.4
Peptone	0.2	8.7
Trypticase	0.2	9.9
Casamino acids	1.0	2.6
with glucose	0.2	3.0
Casamino acids	0.5	2.1
with glucose	0.2	43.0
Casamino acids	0.2	
with glucose	0.2	33.3
Casamino acids	0.2	
with NaCl	0.1	
with glucose	0.2	1.0
Peptone	0.2	
with glucose	0.2	37.1
Peptone	0.06	
with glucose	0.2	7.6
(NH ₄) ₂ SO ₄	0.05	
with glucose	0.2	27.7
NaNO ₃	0.05	
with glucose	0.2	28.2
Mineral base		
with glucose	0.2	3.4

the equivalent amount of nitrogen that the 0.05% ammonium sulfate has. When these two substrates were offered at equal nitrogen concentrations, considerably better growth occurred with the inorganic form. It appears that the nitrogen in ammonium sulfate is available for growth while a large fraction of the nitrogen in the peptone substrate is not available for metabolism. This seems to corroborate the rather restricted pattern of amino acid utilization reported in Table II. The blood fibrin substrate consisted of many 1-2 mm pieces in addition to that which had been solubilized. When the amount of growth was determined these fragments were not included as they would have contributed too greatly to the dry weight. Microscopic examination of these pieces, however, did reveal large numbers of adherent fungi. This explains the comparatively low values reported for this substrate.

Additional growth experiments were carried out with the following substrates serving as the sole source of carbon: acetate, citrate, fumarate, glycerol, alpha-ketoglutarate, lactate, L-malate, propionate, pyruvate, succinate and urea. In no instance did any of the salts of the organic acids support growth. Glycerol yielded only 4 mg of growth. Metabolism of urea was not evaluated on a dry weight basis, but its hydrolysis was evident from the change in color of the pH indicator incorporated into the medium.

Results of the studies dealing with anaerobic growth and the production of lactic acid show that *Phyctochytrium* sp. cannot grow under anaerobic conditions, nor does it accumulate lactic acid in the medium as a result of glucose metabolism.

Discussion

Carbohydrates provide the most readily available source of carbon for this organism. The data show that this isolate is not of importance in the primary degradation of chitinous or cellulosic substrates, but that it could use the hydrolytic products of cellulose if provided by other microbiological activity.

Nitrogen can be supplied in the inorganic form by ammonium or nitrate ions, and in the organic form by certain amino acids, peptones or proteins. It is interesting to note that the amides, asparagine and glutamine, are superior to their respective acids in furnishing a source of available nitrogen. A similar observation has been made previously relative to the use of glutamine by *Rhizophyllum sphaerotheca* (4). Peptones and proteins, although utilized, are not adequate in supporting maximum growth when furnished as the sole source of both carbon and nitrogen. It should be noted, however, that if an available carbon source is present this organism is quite proteolytic. The only exception found was its inability to utilize gelatin extensively. Initial unpublished studies in this laboratory suggest that this proteolytic activity is also a characteristic of an isolate of *Rhizophyllum sphaerotheca*. In the natural environment, where there is a heterogeneity of chemical substrates, chytrids may be of importance

in the turnover of proteinaceous materials. It may be that a more uniform characteristic of chytrids is their proteolytic ability rather than their ability to attack complex polysaccharides, i.e. cellulose and chitin. Protein in the form of human fibrin has been used by Karling (12), as a bait for trapping chytrids. He obtained some new chytrid species which did not grow on the more conventional cellulosic substrates.

It is also of interest that the pattern of amino acid utilization includes the elements of the ornithine cycle. It has been suggested by Cochrane (13) that this cycle may be of importance in fungi in the production of arginine for protein synthesis.

Cantino (14) has characterized the Chytridiales as possessing the ability to 1. utilize sulfate as the sole source of sulfur, 2. synthesize all essential vitamins with the exception that some require thiamine, and one requires biotin and nicotinamide, and 3. use ammonium or nitrate ions as a source of nitrogen although some have lost the ability to use nitrate. The characteristics of the *Phyctochytrium* used in this study coincides with these three attributes, although it should be mentioned that no definitive studies have been made with regard to chytrids and the first point.

In an earlier review of the physiology of chytrids (15), it was indicated that the uniflagellate series of aquatic Phycomycetes have a fermentative metabolism based upon the evidence that they grow under very low oxygen tension, and that a major product of glucose metabolism is lactic acid. This isolate of *Phyctochytrium* does not grow vigorously under reduced oxygen tensions, nor does it produce lactic acids from an ammonium sulfate-glucose medium.

It appears then that at this time there are only three nutritional characteristics which have been established for chytrids, and these are the ones described by Cantino mentioned earlier.

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Urinary Bladder Responses Following Electrical Stimulation of Rostral Areas in The Forebrain of the Cat*

Abstract—The bladder responses in 49 cats were recorded during electrical stimulation of points in rostral areas of the forebrain, of which 27 yielded results suitable for this report. Relaxation of the bladder musculature was the most frequently observed response. The majority of such responses were obtained at frequencies in the range of 25 to 35 per second but, occasionally, higher frequencies were effective in producing inhibitory activity. Excitatory bladder responses were obtained from essentially the same areas as were the inhibitory responses. Four kinds of excitatory responses were observed, one of which resembled the spontaneous rhythm of the intact bladder. Intravesical pressures, in the several experiments, ranged from 10 to 30 cm of water. Bilateral section of the pelvic nerves abolished all inhibitory or excitatory activity evoked by electrical stimulation of forebrain areas.

Eliciting bladder responses from stimulation of the cerebral cortex in man has been strikingly ineffective (1), but in laboratory animals electrical stimulation has regularly produced both excitatory and inhibitory vesical activity (2, 3). The most responsive areas have been the somatic sensory-motor areas I and II and the anterior cingulate gyrus. Other cortical regions which have yielded bladder responses are the premotor area, the caudal portion of the cingulate gyrus, the pyriform cortex and the orbital surface of the frontal lobe.

Subcortical structures in the rostral portion of the forebrain, such as the septal and preoptic regions, also play a role in the control of micturition. From these and other rostral areas contraction as well as relaxation of the detrusor musculature have been obtained (3, 4-10).

Uvnäs (11) and Ström and Uvnäs (12) were among the first to report that the type of bladder response obtained by electrical stimulation of central nervous system structures was influenced by the frequency of the stimulating current employed. They found that the use of low frequencies generally evoked contraction of the detrusor while higher frequencies ordinarily resulted in inhibitory responses. Most excitatory responses, they found, could be

reversed to inhibitory ones by increasing the frequency of the stimulus. Many other investigators have observed an altered response following changes in frequency, but there appeared to be no correlation between the frequency employed and the resulting bladder acitivity (7, 9, 10, 13, 14).

The primary aim of the present investigation was to determine the types of bladder responses to be obtained following stimulation of cortical and subcortical areas in the rostral part of the forebrain and to compare such responses with those obtained by others in the intact and partially denervated preparations. Then too, we considered it important to analyze the respective roles of the sympathetic and parasympathetic systems in bladder function and, finally, to compare the various parameters of stimulation used to alter bladder activity. In a few animals X-irradiation of the midthoracic level of the spinal cord was done in order to observe irradiation effects upon transmission of nervous impulses from the forebrain to the autonomic centers of the bladder in the lower cord.

Materials and Methods

The bladder responses in 49 cats were recorded during electrical stimulation of points in the rostral portion of the forebrain, of which 27 yielded results suitable for this report. Following intraperitoneal injections of chloralosane and pentobarbital sodium, the brain was exposed and the stereotaxic instrument attached to the head. The animal was then placed in a supine position and the bladder and the sympathetic and parasympathetic nerves to the viscera exposed through a midline incision. A small cannula was attached to the urethral end of the bladder and then connected with rubber tubing to a constant pressure apparatus (15). (The intravesical pressure for any experiment was held constant and the record indicates volume changes of the bladder during stimulation of the point in the forebrain. Pressures were maintained at levels ranging from 4 to 20 cm H₂O and seemed to play no role in the type of response obtained.) The whole apparatus was then

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filled with a warm saline solution and, when in operation, recorded on kymograph paper the total bladder response. On the ventral surface of the bladder were placed small squares of white adhesive paper each bearing a small black dot in its center. The paper squares were so arranged as to divide the exposed surface of the bladder into quadrants and 12 areas (16). By means of a 16 mm motion picture camera, mounted directly above the bladder, color photographs were taken at approximately one-second intervals during the course of each observation. Subsequently, by projecting the film upon suitable paper, measurements were made and the results plotted of the activity taking place per unit length of muscle in each of the 12 areas during each second of the experiment.

Bipolar electrodes, made of two pieces of nichrome wire cemented together and insulated except at their tips, were used. Minimal strength (8 to 12 volts), square wave stimuli were supplied by a Grass S4A stimulator. Frequencies of 6 to 100 and pulse durations of 3 to 10 msec were employed. When a bladder response was obtained several observations were made from this reactive point. First, different frequencies and pulse durations were tried and finally some portion of the autonomic innervation to the bladder was sectioned. After each change in frequency or section of nerves, the point was restimulated and the results recorded. At the conclusion of an experiment the brain was perfused with a normal saline solution, then injected with 10% buffered formalin, the brain removed, sectioned, stained and the reactive point identified.

In four cats (Tables I and II) bladder responses were obtained from reactive points in the forebrain after administration of 3,000 R x-irradiation directed to the midthoracic level of the spinal cord. All cats were healthy at the time of sacrifice (81 to 127 days postradiation) and none exhibited any signs of incontinence or other neurological deficits. At the conclusion of the experiment the irradiated portion of the spinal cord was fixed in formalin-ammonium bromide and stained by the Cajal gold

TABLE I
BRAIN AREAS WHICH ELICITED INHIBITORY BLADDER RESPONSES

CAT	BRAIN AREA STIMULATED ^c	PERIPHERAL INNervation	FREQUENCY PER SEC.	PULSE DURATION IN MSEC.	BLADDER RESPONSE ^d			
					△	▲	□	■
4 ^a	F F F	Insect HS ^b HS	30 60 10	5 5 5	↑↑	↑↑	↓↓	↓↓
14 ^b	CC CC	Insect PS	30 30	5 5	↑↑	↑↑	↓↓	↓↓
15	CC CC	Insect PS	30 30	5 5	↑↑	↑↑	↓↓	↓↓
17	IC IC	Insect PS	30 30	5 5	↑↑	↑↑	↓↓	↓↓
36	SG ^d SG SG	Insect Insect PS	100 30 30	3.5 5 5	weak	↑↑	↓↓	↓↓
23	C CC CCC	Insect Insect Insect PS	30 30 100 30	5 5 5 5	↑↑	↑↑	↓↓	↓↓
27	C C C	Insect Insect PS	30 100 30	4 3 4	↑↑	↑↑	↓↓	↓↓
29	Olf. Olf. Tub. Olf. Tub.	Insect Insect	35 100	5 3.5	↑↑	↑↑	↓↓	↓↓

TABLE I (Cont.)

CAT	BRAIN AREA STIMULATED ^a	PERIPHERAL INNervation	FREQUENCY PER SEC.	PULSE DURATION IN MSEC.	BLADDER RESPONSES			
					Δ	▲	□	■
16	S	Insect	P5	30	5		○	
					5			
28	Nuc. Acc. Nuc. Acc. Nuc. Acc.	Insect	PS	30	5		○	
		Insect	PS	100	3.5		○	
		Insect	PS	8	5		○	
37	Nuc. Acc. Nuc. Acc. Nuc. Acc.	Insect	PS	30	5		○	
					5			
6	IC IC IC	Insect	PS	25	5		○	
		HS	PS	25	5		○	
		IC	PS	100	5		○	
9c	Olf. Tub. Olf. Tub.	Insect	PS	30	5		○	
					5			
22	CC CC	Insect	PS	100	5		○	
		Insect	PS	30	5		○	
26	C	Insect	PS	35	5		○	
					5			
33	S S S	Insect	PS	20	5		○	
		Insect	PS	100	5		○	
		Insect	PS	30	2.5		○	

a. Midthoracic spinal cord administered 3,000 R with 300 kVp x-ray

^b Midthoracic spinal cord administered 3,000 R with 1,000 kVp x-ray machine at the rate of 850 R per minute (81 days post-radiation).

e. Midthoracic spinal cord administered 3,000 R with 1,000 kVp x-ray machine at the rate of 850 R per minute (127 days post-syndrome).

^a See Fig. 1 through 4 for key to abbreviations and symbols in Tables I and II.

e. Other abbreviations and symbols in Tables I and II: \downarrow indicates bladder response; 0 indicates no bladder response; HS indicates hypogastric nerves sectioned; PS indicates pelvic nerves sectioned; RPS indicates right pelvic nerve sectioned; SG indicates sigmoid gyrus; AEG indicates ectosigmoid gyrus.

chloride method. Light microscope study of the sections revealed an almost complete loss of nerve cells in the irradiated portion of the cord with greatly hypertrophied and deeply staining astrocytes in the gray matter.

TABLE II
BRAIN AREAS WHICH ELICITED EXCITATORY BLADDER RESPONSES

CAT	BRAIN AREA STIMULATED	PERIPHERAL INNERVATION	FREQUENCY P/S SEC.	PULSE DURATION IN MSEC.	BLADDER RESPONSE			
					○	●	□	⊕
18	CG CG CG	Inbct Inbct PS	30 30 30	0.1-0.2	+	-	+	-
24	ARG ARG ARG	Inbct Inbct PS	30 100 100	0.1-0.2	+	-	+	-
30	S S	Inbct Inbct	15 100	0.2-0.5	+	-	+	-
31	CG CG CG	Inbct Inbct Inbct	30 10 100	0.1-0.2	+	-	+	-
8*	NVA NVA NVA	Inbct Inbct PS	30 30 30	0.1-0.2	+	-	+	-
25	C C C	Inbct Inbct PS	30 100 100	0.1-0.2	+	-	+	-
33	P P	Inbct PS	30 30	0.1-0.2	+	-	+	-
21	SG SG SG	Inbct Inbct PS	10 100 100	0.1-0.2	+	-	+	-
7	IC IC	Inbct HS	25 25	0.1-0.2	+	-	+	-
19	Off. Tub. Off. Tub.	Inbct PS	30 30	0.1-0.2	+	-	+	-
34	C C	Inbct PS	30 30	0.1-0.2	+	-	+	-

- Midthoracic spinal cord administered 3,000 R with 1,000 kVp x-ray machine at the rate of 830 R per minute, (95 days Post Radiation).

b. NO response on denervated side.

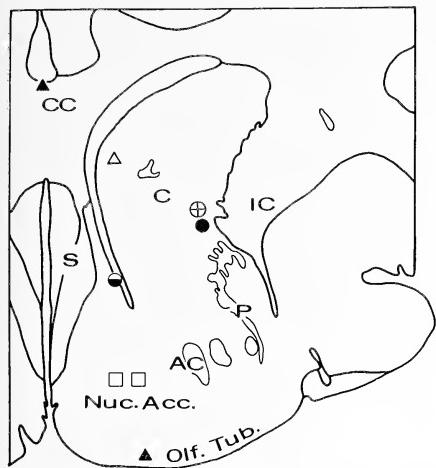


FIG. 1—Localization of points yielding bladder responses at level A 18.0.

FIG. 1 through 4 are adapted from *A Stereotaxic Atlas of the Cat Brain* (24). Abbreviations: AC = anterior commissure; Amygd = amygdaloid nucleus; C = caudate nucleus; CC = corpus callosum; CG = cingulate gyrus; F = fornix; Hypoth = hypothalamus; IC = internal capsule; Nuc. Acc. = nucleus accumbens; NVA = nucleus anterior ventralis; Olf. Tub = tuberculum olfactorium; OT = optic tract; P = putamen; S = spatal area; Thal = thalamus. Symbols: △ = slight relaxation followed by slow recovery; ▲ = marked relaxation with suppression of spontaneous rhythm; □ = slight relaxation during stimulation followed by vigorous contraction; ■ = vigorous relaxation during stimulation followed by marked contraction; ○ = moderate contraction during stimulation; ● = sustained contraction during stimulation followed by slow relaxation; ⊕ = marked hypogastric-like contraction; ⊕ = spontaneous-like period of stimulation.

Results

Inhibitory bladder responses: Relaxation of the bladder musculature was the most frequently observed response following electrical stimulation of rostrally situated forebrain structures. The majority of these responses were obtained at frequencies in the range of 25 to 35 per second but, occasionally, higher frequencies were effective in producing inhibitory activity. Intravesical pressures, in the several experiments, ranged from 10 to 30 cm H₂O. Section of the hypogastric nerves was ineffective in altering the response but bilateral pelvic nerve section abolished all vesical activity including any spontaneous rhythm, if present, and invariably led to an increase in the volume of the bladder.

For the purposes of description the inhibitory responses were divided into four groups. In one of these (open triangle, Table I and Fig. 1, 2, 3 and 4)

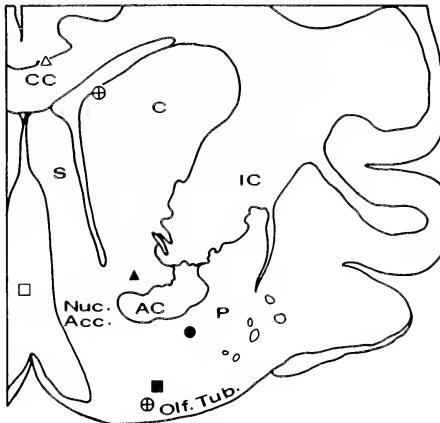


FIG. 2—Localization of points yielding bladder responses at A 16.0.

the initial response was a slight relaxation of the bladder musculature with a very slow recovery at cessation of stimulation. In one animal stimulation of the fornix produced relaxation of the viscera at a frequency of 30 per second (Fig. 5, upper curves). Section of the hypogastric nerves and restimulation at a frequency of 60 per second did not alter the re-

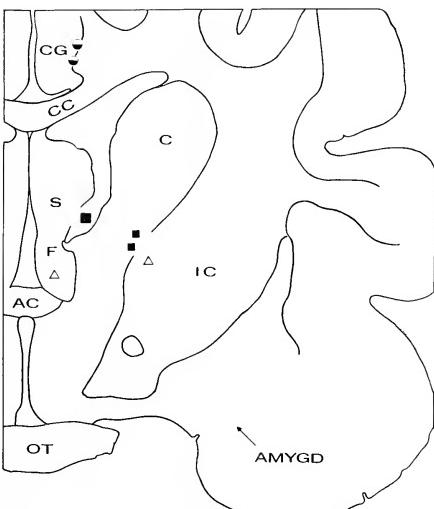


FIG. 3—Localization of points yielding bladder responses at A 13.5.

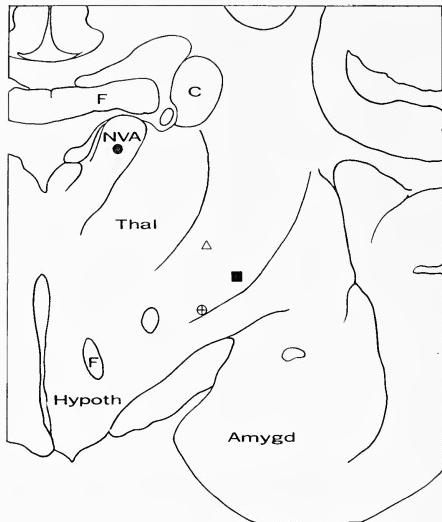


FIG. 4—Localization of points yielding bladder responses at A 11.5.

sponse (lower curves) but no bladder activity was obtained at a frequency of 10 per second.

Another type of inhibitory response was characterized by a marked relaxation combined with suppression of any spontaneous rhythm present and with immediate contraction at cessation of stimulation (closed triangle, Table I and Fig. 1 and 2). In one cat exhibiting this type of relaxation stimulation of a point in the olfactory tubercle at a frequency of 35 per second (Fig. 6, upper curves) and at 100 per second (lower curves) gave almost identical results, i.e., inhibition of the spontaneous rhythm and marked relaxation of the detrusor muscle. A third type of inhibitory reaction was a slight relaxation of the bladder during stimulation with marked contraction at cessation of stimulation (open square, Table I and Fig. 1 and 2). These responses were obtained from the septal area and nucleus accumbens at a frequency of 30 per second. Higher and lower frequencies were ineffective.

The fourth type of inhibitory response was characterized by a marked relaxation during stimulation followed by a vigorous contraction (closed square, Table I and Fig. 2, 3 and 4). In one of these observations (Fig. 7) stimulation of a point in the internal capsule at a frequency of 25 per second elicited a vigorous response (upper curves) while stimulation at a frequency of 100 per second after section of the hypogastries gave a slightly less vigorous reaction (lower curves). In another cat in this series (Fig. 8) a good response was elicited from a point in the septal area at a frequency of 30 per second, but there

was no response when the frequency was raised to 100 per second.

Excitatory bladder responses: The areas of the brain which, upon stimulation, elicited contraction of the bladder are shown in Table II and in Fig. 1, 2, 3 and 4. The intravesical pressures ranged from 7 to 31 cm H₂O and the frequencies most frequently employed were from 25 to 35 per second although frequencies as high as 100 per second occasionally evoked excitatory behavior. Bilateral section of the pelvic nerves always abolished this response as well as any spontaneous rhythm present at time of cutting the nerves.

Four different kinds of excitatory bladder reactions were recorded. The most frequently observed was a moderate contraction of the bladder during the period of stimulation (lower half of circle solid, Table II Fig. 1 and 3). These responses were obtained from the septal area, cingulate and anterior ectosylvian gyri at frequencies of 15 to 30 per second. In one cat (No. 24) increasing the frequency from 30 to 100 per second altered the response from a moderate contraction to a spontaneous-like rhythm of the bladder. In another animal (No. 31) a good response was obtained at a frequency of 30 per second with a very weak reaction at frequencies of 10 or 100 per second.

Another type of excitatory behavior was the sustained contraction during stimulation followed by a slow relaxation (solid circle, Table II). In one cat (Fig. 9) stimulation of a point in the putamen at a frequency of 30 per second resulted in an immediate

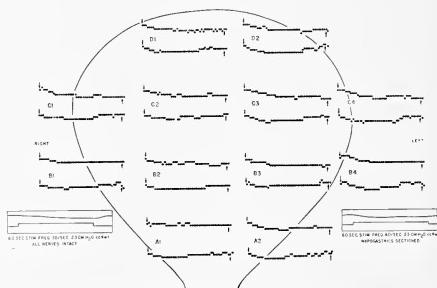


FIG. 5—Bladder responses in cat 4 after stimulation of fornix with intravesical pressure held constant at 23 cm H₂O. Upper curves: frequency 30 per second, intact nerves; lower curves, frequency 60 per second, hypogastric nerves sectioned.

Figs. 5 through 11 are outline sketches of muscle activity taking place upon the ventral surface of the bladder in each of 12 areas (A1 through D2). Each circle represents activity during each second (approximately) of observation. Onset of stimulation indicated by downward pointing arrow, cessation of stimulation by upward pointing arrow. A graph with an upward curve indicates contraction, a downward curve, relaxation. Insets: kymograph of bladder volume during each observation; upstroke indicates diminution of volume.

and sustained contraction which relaxed very slowly upon cessation of stimulation. In another animal stimulation of the caudate nucleus at a frequency of 30 per second evoked an immediate and vigorous contraction (Fig. 10, upper curves) but when the frequency was increased to 100 per second the response was a spontaneous-like rhythm of the bladder (lower curves).

In other cats stimulation of points in the forebrain elicited a pattern of activity similar to the spontaneous rhythm of the bladder described above (cross within a circle, Table II, cats No. 7, 19, 34). In these animals stimulation of the caudate nucleus, internal capsule or olfactory tubercle at a frequency of 25 to 30 per second elicited the spontaneous-like rhythm. Section of the pelvic nerves abolished this response.

In one animal (left half of circle solid, Table II) stimulation of a point in the sigmoid gyrus at a frequency of 100 per second elicited a marked contraction which resembled a hypogastric-like response (Fig. 11) (14). Although this contraction had a very short latent period, relaxation began after 15 seconds even though stimulation was continued for another 15 seconds. This response did not repeat at a frequency of 10 per second and was abolished by section of the pelvic nerves.

Discussion

Relaxation of the bladder musculature, generally with interruption of any spontaneous rhythm if present, was elicited from stimulation of points in both cortical and subcortical structures in the rostral portion of the forebrain. Most of the responses were obtained at frequencies of 25 to 35 per second with only an occasional relaxation evoked from frequencies below 20 or above 60 per second. There was no correlation between the intravesical pressure employed and the type of response obtained. Section of the pelvic nerves always abolished the response.

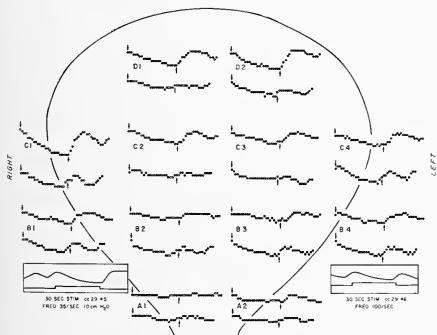


FIG. 6—Bladder responses in cat 29 after stimulation of olfactory tubercle with intravesical pressure held constant at 10 cm H₂O. Upper curves: frequency 35 per second; lower curves, frequency 100 per second.

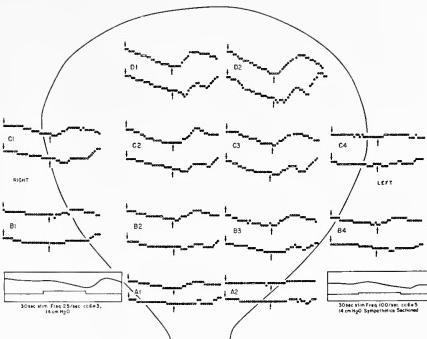


FIG. 7—Bladder responses in cat 6 after stimulation of internal capsule with intravesical pressure held constant at 14 cm H₂O. Upper curves: frequency 25 per second, intact nerves; lower curves: frequency 100 per second, hypogastric nerves sectioned.

In the two cats in which the hypogastric nerves were sectioned, no change in the behavior of the bladder was observed.

The function of this forebrain inhibitory mechanism is little understood. Kurin (3) suggested that it plays an important role in the storage of urine by inhibiting vesical contraction due to increased vesical contents. It is conceivable, as Andrew and Nathan (17) have postulated, that damage to the brain areas or to the descending pathways which control inhibitory activity could lead to frequency and urgency in the patient. The inhibitory system is not a pure sympathetic response since it is abolished by section of the pelvic nerves. Nor is it controlled from any specific area of the brain, such as the posterior hypothalamus, as Beattie and Kerr (18) believed.

Excitatory bladder responses were elicited from many of the same areas of the brain from which relaxation was obtained. The optimal frequency was in the range of 25 to 35 per second with an occasional contraction obtained at a frequency of 100 per second. In two animals changing the frequency altered the response from contraction to a spontaneous-like rhythm of the viscera. In none of our experiments did changing the frequency alter a response from that of excitation to inhibition or *vice versa*. Section of the pelvic nerves always abolished the response. There was no correlation between the intravesical pressure and the type of response obtained.

In several animals electrical stimulation of rostral forebrain structures induced a slow wave of contraction and relaxation which simulated the spontaneous rhythm so characteristic of the viscera. This rhythm subsided upon cessation of stimulation and was abolished by section of the pelvic nerves. Grossman and Wang (7) obtained similar responses following stimulation of the septal and preoptic areas at

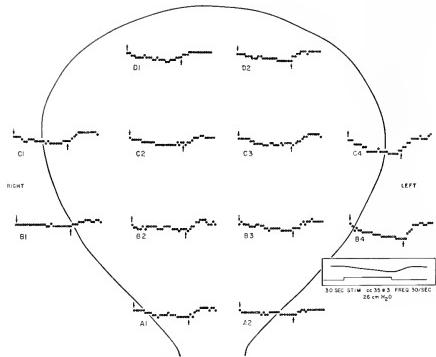


FIG. 8—Bladder response in cat 35 after stimulation of septal area with intravesical pressure held constant at 26 cm H₂O and at a frequency of 30 per second.

very low frequencies but at higher frequencies the response became a simple contraction. Such observations would suggest that there is at least one type of spontaneous rhythm under the control of the central nervous system.

As a final procedure in 20 of our experiments the pelvic nerves were sectioned bilaterally, which immediately abolished any spontaneous rhythm, if present, and invariably led to an increased volume of the viscus. Wang and Harrison (19) found no change in the bladder tonus after section of the sacral roots bilaterally but this procedure abolished the spontaneous rhythm when it was present before denervation. Barrington (20) observed that division of both pelvic nerves in an otherwise intact cat produced, with great constancy, a relaxation of the bladder, and any marked rhythmical undulations which may have been present before were

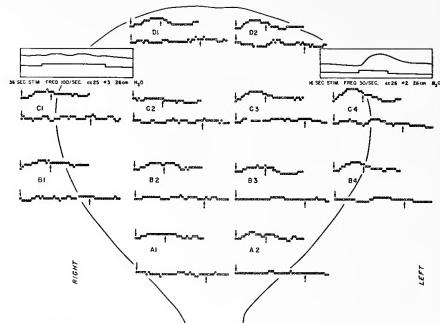


FIG. 10—Bladder responses in cat 25 after stimulation of caudate nucleus with intravesical pressure held constant at 26 cm H₂O. Upper curves: frequency 30 per second; lower curves: frequency 100 per second.

completely abolished or greatly diminished. This is at variance with the observations of many workers (2, 21, 22) who found that rhythmic activity was independent of the extrinsic nerves of the bladder. Gjone (23) found, however, that if the parasympathetic outflow was sectioned with the sympathetic still intact, all rhythmic activity would cease. Our experiments differ from those of most investigators in that the intravesical pressure remains constant but the volume of the viscus can vary within wide limits, which may account for the differences in the results obtained.

Conclusions

From electrical stimulation of points in the cortical and subcortical areas of the rostral portions of the forebrain in 27 adult cats, the following conclusions were made:

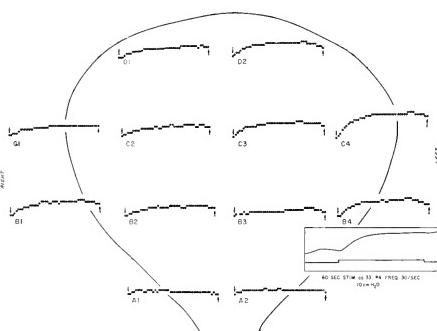


FIG. 9—Bladder response in cat 13 after stimulation of putamen with intravesical pressure at 10 cm H₂O and a frequency of 30 per second.

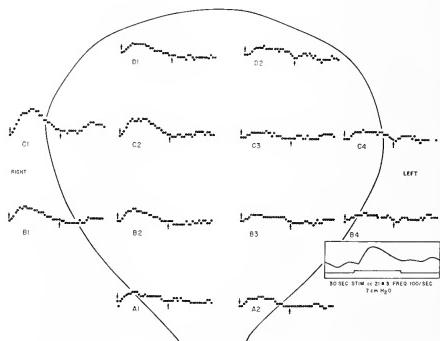


FIG. 11—Bladder response in cat 21 after stimulation of sigmoid gyrus with intravesical pressure held constant at 7 cm H₂O and a frequency of 100 per second.

- 1) Inhibitory bladder responses were obtained from both the cortex and subcortical structures following stimulation at frequencies from 30 to 100 per second and at pulse durations of 3 to 5 msec. Intravesical pressures ranged from 10 to 30 cm H₂O. Four different kinds of inhibitory responses were described. All were abolished by section of the pelvic nerves and were unaffected by hypogastric section.
- 2) Excitatory bladder responses were obtained from essentially the same areas of the brain and at the same frequencies and intravesical pressures as were the inhibitory responses. Four kinds of excitatory bladder activity were described, one of which resembled the spontaneous rhythm of the intact bladder. All four types of responses were abolished by section of the pelvic nerves.
- 3) Section of the pelvic nerves abolished any spontaneous rhythm present at the time of section and, in addition, invariably led to an increased bladder volume.
- 4) X-irradiation of the midthoracic level of the cord at the dose level employed had no effect upon the transmission of nervous impulses from the forebrain to the lower autonomic centers of the cord.
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Strobilation of *Chrysaora quinquecirrha* Polyps in the Laboratory*

Abstract—The scyphistoma of *Chrysaora quinquecirrha* was induced to strobilate in the laboratory. Detailed description of the process is given.

Just prior to strobilation, the goblet-shaped polyp undergoes color change and clefting. Each scyphistoma typically releases five ephyrae. Terminal tentacles are resorbed during strobilation and appear near its completion at the base of the strobila.

Upon release, ephyrae swim to the surface and attempt to maintain their position there. Strobilation is normally complete in 20–25 hours after clefting. All stages survive well on *Artemia*, enchytraeids, ground ctenophores, and similar food.

During a long-range study of the Chesapeake Bay sea nettle *Chrysaora quinquecirrha* DeSor, strobilation of the polyp was induced and the entire process observed. The present paper presents details of timing and behavior not given by Littleford (1) in his account of strobilation. Notable articles dealing with this process in other species include those of Spannberg (2, 3) for *Aurelia* and Kakinuma (4) for *Dactyloctena pacifica*.

Polyps utilized in this investigation were obtained from oyster shells dredged at Roane Point in the York River, Virginia. Shells were obtained during January, when water temperature ranged from 3 to 5° C and salinity from 12 to 15 parts per thousand (o/oo). Shells with 83 attached polyps were cleaned of extraneous fouling and held at ambient temperature in a 20 liter Plexiglass aquarium. Salt water was allowed to flow during the day, but the flow was shut off during the night to facilitate feeding the polyps with *Artemia*.

After a two week period of acclimation, the aquarium was enclosed in a three inch thick cube of styrofoam. An air tube and thermometer were placed in the aquarium and the salt water flow was cut off; salinity at this time was 18.4 o/oo. Temperature of the standing water was allowed to rise gradually at the rate of about 1.5° C over a period of about 10 days. When the temperature reached 17° C, supplemental heating was necessary to raise the temperature to 20° C. When the water temperature reached 20° C, about 12 days after heating started, strobila-

tion began and continued over a period of about two weeks.

Strobilation ceased if the temperature was decreased suddenly to 3 to 5° C, and the polyps gradually returned to the typical overwintering form. Strobilation could again be induced in the same individuals by heating the water as previously outlined. The present study was carried out with polyps that had been previously strobilated.

The normal polypoid form of *Chrysaora quinquecirrha* possesses 16 long, knotted tentacles surrounding a raised mouth. Normal polyp height ranges between 0.8 mm and 2.0 mm. The slender base of the goblet-shaped body broadens at the bottom to form a basal disc (Fig. 1).

Several days prior to strobilation, a definite color change occurred in the polyps. Their typical off-white color changed to pale pink and then gradually deepened to red or crimson. During this color change, and approximately 72 hours before the budding off of the first ephyra, visible clefts began to appear at five points radially along the length of the polyp (Fig. 2). Within 24 to 48 hours the clefts deepened until five distinct discs became visible, each connected to the other by a thin filament. Discs were smaller near the base of the polyp, the terminal disc being $\frac{1}{3}$ larger than the disc directly beneath it. With the deepening of the clefts, terminal tentacles on the polyp were resorbed (Fig. 3).

With the formation of the discs, each developed eight bifid "arms" (which later form part of the bell) and began spasmodic pulsations. The characteristic jerking motion of strobilation did not occur in the entire polyp but only in the terminal disc. Pulsations were similar to those of the normal free-swimming ephyra. The contractions varied in number from a single pulse to five or six in succession. The total series took between three and five seconds.

Approximately one hour before separation of the terminal disc, the disc immediately beneath it began to enlarge and pulsate, often in unison with the terminal disc.

Each strobile disc required at least four hours to separate. Since five discs were present on each polyp, 20–25 hours were required for the completion of strobilation of a single polyp after clefting.

When only two strobile discs remained, polyp tentacles began to reappear beneath the last disc and

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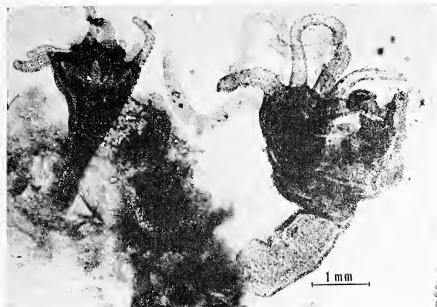


FIG. 1—Normal polyp of *C. quinquecirrha*. Tentacles clumped due to preservation and mounting.

enlarged throughout the strobilation of the remaining ephyrae. The tentacles were near normal size when the last disc had separated. The pulse period for the last disc was usually somewhat longer than for the previous four, being three to eight seconds in duration. Contraction rate was normal immediately before separation. The pulses continued until disc separation was completed. Polyps assumed normal appearance 24–72 hours after separation of the last disc.

All polyps observed produced five ephyrae each, with the exception of one which produced six. After strobilation many of the polyps gave rise to stolons, and there was a general increase in colony size.

During clefting of the polyp, the discs were separated by a clear stalk, with a central bright red fiber (Fig. 3). Although the stalk appeared thick there was a cleft in the clear portion and the actual connection was by the red fiber only. As the terminal disc pulsated, the fiber holding it to the others became very thin and finally parted as the ephyra broke free. The remaining clear, thick portion of the stalk appeared to become the manubrium of the next ephyra. Several hours before separation this manu-



FIG. 3—Strobilating polyp with 4 developing ephyrae. A = attaching filament.

brium-like structure began to twitch and infolding occurred (Fig. 4).

The newly-strobilated ephyra was inverted when compared to the adult, swimming with the manubrium in a dorsal position rather than a ventral one. The body was light pink with several very prominent deep-red regions (Fig. 5). The red portions were the tentaculocysts, the manubrium, and the tips of the bifid arms. Lambert (5) believes the intensity of this color is dependent on the intensity of the light reaching the polyp at the time of strobilation. At the time of release, the ephyra had no tentacles and propelled itself with a series of rapid pulses (five or six) alternated with slight pauses that equaled in duration two or three contractions. Each pulse propelled the ephyra approximately 0.75 mm.

Immediately after release from the polyp, ephyrae moved to the surface of the container and attempted to maintain their position there. Lambert (5) has suggested this to be a phototactic response.

Approximately 96–120 hours after release, the red portions of the ephyra became more prominent and the remaining portions began to clear. In about



FIG. 2—Polyp in early indentation stage of strobilation.



FIG. 4—Ephyra showing the infolded manubrium.

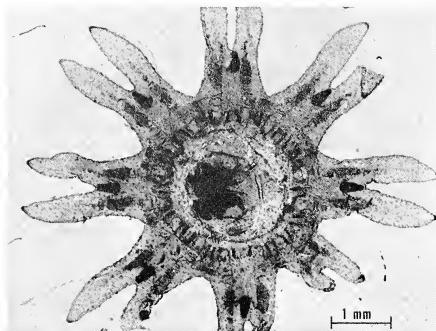


FIG. 5—24-hour ephyra.

two weeks, the area between the bifid arms was filled in, the bell everted, and the red regions faded as the animal assumed its adult milky-white color (Fig. 6).

All developing stages were found to ingest a wide variety of organisms. Foods shown by other authors to be acceptable for coelenterate life stages include *Artemia*, plankton, liquid *Nereis*, small neids, *Dendroboena subrubicunda*, *Obelia*, young jellyfishes, small copepods, *Clione*, *Limacina*, and hamburger, (1, 2, 5-8). During the present investigation, all stages fed actively on *Artemia*, enchytraeids, polychaeta larva, and strained ctenophores. Lambert (5) found the ephyrae of a British spe-

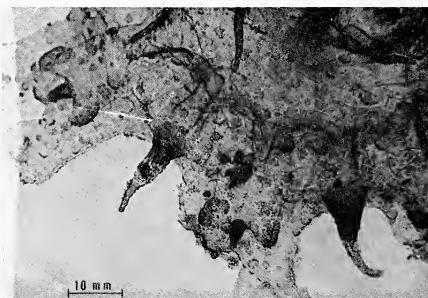


FIG. 6—240-hour ephyra showing advanced development of bell and primary tentacles.

cies of *Chrysaora* to be cannibalistic. He also found ctenophores to be the only food accepted by *Chrysaora* ephyrae larger than $\frac{1}{3}$ inch.

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The Miocene-Pleistocene Unconformity in Norfolk County, Virginia

Abstract—The Miocene-Pleistocene boundary in Norfolk County, Virginia as exposed in a borrow pit near Deep Creek is a disconformity. The contact is emphasized by a 1 to 3 foot thick layer of indurated limonitic sand, armored mudballs and well-rounded pebbles and cobbles of quartz, granite, gneiss and conglomerate. Both electric and drillers' logs were used to trace the disconformity in the subsurface. The overlying Pleistocene thickens rapidly to the east of a NW-SE line which is congruent with the eastern edge of the Dismal Swamp and the Southern Branch of the Elizabeth River. This eastward thickening is due to an increase in the dip of the Yorktown Formation of upper Miocene age.

Miocene-Pleistocene Boundary

The Yorktown Formation is separated from Pleistocene sediments by a disconformity where it is exposed in a borrow pit near Deep Creek, Norfolk County, Virginia (Fig. 1 and 2, a and b). Above this disconformity, there is a zone of armored mudballs, indurated limonitic sand, and well-rounded pebbles and cobbles of quartz, granite, gneiss and conglomerate. The mudballs (Fig. 2c) range from 2 to 8 inches in diameter, 0.52 to 0.91 in sphericity, and in shape from discoidal to rodshaped to spheroidal. Their internal composition is predominately gray clay and iron in a reduced state. A few of the mudballs have a silt to fine sand and clay core. Their exteriors, in addition to mudcracks, are armored with a coating of small pebbles, medium to coarse sand, and shell fragments. Specimens found *in situ* commonly have a greater concentration of mudcracks on the upper surface. In addition, stronger oxidation on the upper surface gives a dark red to maroon color while the lower surface is light to dark gray in color.

A detailed stratigraphic section of the Deep Creek borrow pit is given below and illustrate in Fig. 3:

- | | |
|---------|---|
| 0'-5' | Brown clay |
| 5'-20' | Light brown to white, fine to medium grained, cross-bed'd sand with many lenses and pods of brown to black, blocky clay. Varies from 10 to 15 feet. |
| 20'-30' | Blue-gray to brown-gray fine grained sand with lenses and channels of blue- |

gray clay and lignitic material consisting of tree limbs and branches; interingers with lenses of Pleistocene fossil hash. Scattered pebbled and cobbles near base.

- 30'-33' Yellow-brown to dark red iron stained clay sand, strongly indurated locally

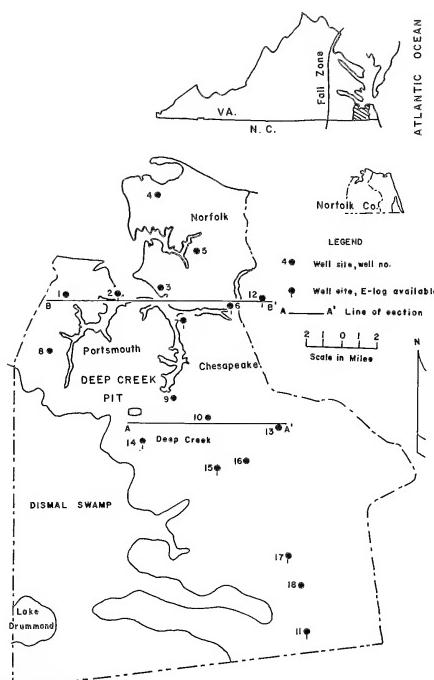


FIG. 1.—Location map of exposed disconformity at Deep Creek borrow pit and well logs used in the area.

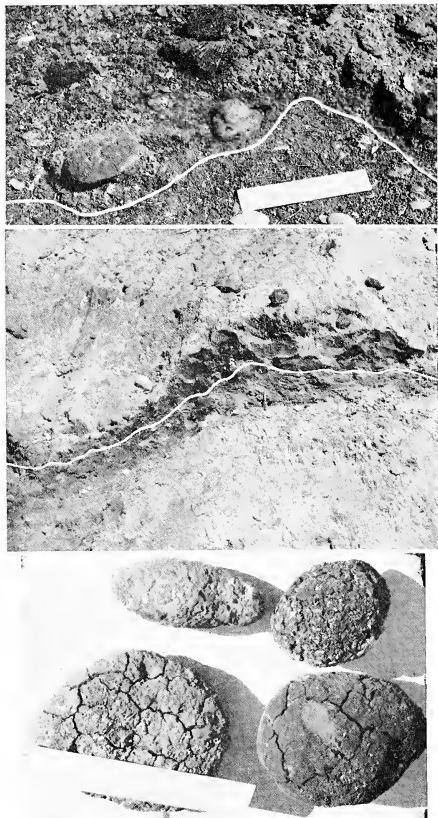


FIG. 2 (a)—Exposure of Miocene (Yorktown Formation)—Pleistocene (Nansemond Formation) disconformity (white line) on southwest wall of Deep Creek borrow pit, armored mudballs and cobble (center) above unconformity. Scale is 6 inch ruler. (top)

(b)—Disconformity (white line) between Miocene (Yorktown Formation) and Pleistocene (Nansemond Formation) on southeast wall of Deep Creek borrow pit, showing armored mudballs (center) and cobbles (right and left of center) above disconformity. Scale is a 5 inch ball point pen. (Center)

(c)—Selected armored mudballs showing mudcracks, shell composition of armor and variation in shape. Scale is a 15 cm metric ruler. (bottom)

and containing armored mudballs and hematite nodules concentrated near bottom with well rounded pebbles and cobbles of quartz, granite, gneiss, and conglomerate scattered throughout zone. Varies from 1 to 3 feet.

33'-43' Light blue-gray to brown-gray clayey sand and sandy clay tightly packed with Miocene fossils.

Based on paleontologic data detailed below, the material above the disconformity is of Pleistocene age. Depending on the individual's interpretation of the stratigraphy, this Pleistocene material can be considered to be either the Nansemond Formation (1) as used by Rogers and Spencer (2), or the Great Bridge, Norfolk and Sandbridge Formations

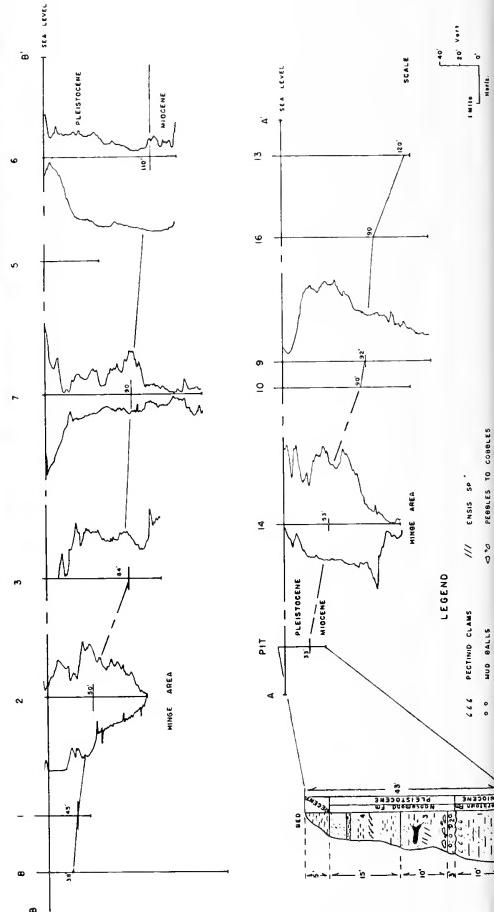


TABLE I

Relationship of total depth of well to thickness of Pleistocene encountered

Well No.	1	2	3	4	5	6	7	8	9	feet
Total Depth	65	100	126	120	53	140	166	200	130	
Thickness of Pleistocene	25	31	48	120	53+	110	55	25	36	feet

as defined by Oaks and Coch (3-5). Based on paleontologic criteria again, the material below the disconformity is of upper Miocene age, and is considered to be the Yorktown Formation (1, 6).

The disconformity can be traced in the subsurface of Norfolk County from electric logs and drillers' logs (Fig. 3). On electric logs it is expressed by a characteristic increase in resistance of the resistivity curve and concomitantly a positive deflation of the self potential curve. The contact is picked on drillers' logs at the first recorded significant thickness of "blue mud and shell." Total depth of the wells and the thickness of the encountered Pleistocene are shown in Table I. Correlation of these data, as shown in Figure 2, reflects a sharp increase in the dip of the Yorktown Formation and an eastward thickening of the Nansemond Formation beginning at a NW-SE line congruent with the extreme edge of the Dismal Swamp and the course of the Southern Branch of the Elizabeth River. West of this line of flexure the Nansemond Formation has an average thickness of 20 feet; to the east the formation rapidly increases to a thickness of 120 feet near the Norfolk-Princess Anne County line and to a minimum of 200 feet at the community of Creeds in the southern part of Princess Anne County (2).

Paleontology

A varied assemblage of macro- and microfossils occurs within the sediments immediately below the disconformity. Of the assemblage *Murrayina barclayi* McLean, *Cytheropteron talquinensis* Puri, *Paracypris choctawhatcheensis* Puri, *Elphidium johnstonae* McLean, *Quinqueloculina seminulangulata* McLean, *Callistoma virginicum* (Conrad),

TABLE I—continued

Well No.	10	11	12	13	14	15	16	17	18	feet
Total Depth	130	124	98	130	120	65	160	100	100	
Thickness of Pleistocene	78	70	98+	109	24	57	80	77	77	feet

Ptychosalpinx altilis (Conrad), *P. laqueata* (Conrad), *Terebra (Strioterebrum) neglecta* (Emmons), *Chlamys (Lyropecten) jeffersonian* (Day), *Abra subreflexa* (Conrad), *Macoma virginiana* (Conrad), and *Phacooides (Lucinisca) cibrarius* (Say) are restricted to or are considered indicative of the upper Miocene Yorktown Formation (7-11).

Above this unconformity, the predominately arenaceous material contains a less varied and less abundant faunal assemblage. Of this assemblage *Elphidium florentine* Shupack, *E. clavatum* Cushman, *Cushmanidea echolsae* (Malkin), *Triglymmus arenicola* (Cushman), *Busycon carica* (Gmelin), *Corbula contracta* Say, *Ensis minor* Dall, and *Pitar morruhuana* (Linsley) indicate a Pleistocene age (6, 12, 13).

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Karyotype Studies: A Rapid Squash Method for Making Permanent Chromosome Slides from Early Developmental Stages of Small Eggs

Abstract—Metaphase configurations of the first several cleavage divisions in mites (Sarcoptiformes: Anoetidae) provide excellent material for cytogenetic studies. Early cleaving eggs are predictably obtained from gravid females selected from a thriving colony. Air drying both slide and cover glass after fixation in Carnoy (6:3:1), permits storage for as long as several weeks before staining. A modified Schiff's reagent (5 mg/ml) and toluidine blue O (1 mg/ml) buffered at pH 5.3-5.5 are used as stains which yield material for study with high contrast between chromosomes and cytoplasm.

Karyotype studies in animals are generally dependent upon a convenient source of somatic metaphase configurations from which the position of primary and secondary constrictions, presence of satellites, and other morphological details for each chromosome can be readily ascertained. For such studies in many animal groups, such as some small arthropods, e.g., Acarina, the tissue of choice is often found to be the developing egg. The chromosomes of many, if not most acarids, are largest during early cleavage stages (1, 2). At this time the chromosomes are more consistent in observable relative morphological detail.

Eggs have the following advantages over many other tissues: a) the same type of tissue can be utilized for both sexes, b) development usually begins before oviposition, and c) dissected eggs afford positive association with the correct species and thus avoid errors due to contamination of oviposited eggs by another species.

The following procedure has been used most extensively in the family anoetidae (Acarina) but is suitable without or with slight modifications in other small arthropods:

- 1) Eggs are dissected from gravid females in a drop of distilled water on one end of a clean slide. Only active females from a thriving colony are selected because there is a tendency for sluggish females from an overcrowded colony to have fewer and more highly developed eggs (3).
- 2) Eggs are moved to the middle of the slide in a small droplet of water. Debris and excess water are blotted from the slide and a drop of Carnoy's (6:3:1) fixative (absolute alcohol: anhydrous chloroform: glacial acetic acid) is allowed to flow

over the eggs. The eggs are then squashed under a cover glass using a needle to exert pressure on individual eggs if necessary.

3) The slide with its cover glass is inverted in a petri dish containing the fixative with one end of the slide supported by a small glass rod to facilitate the separation of cover glass from the slide. The slide and cover glass are air dried and then stained at once, or they can be stored for as long as several weeks.

4) The slide and cover glass are stained as follows:

Hydrolyze in 1 N HCl (60°C) for 7-8 min, rinse in distilled water, stain in Schiff's reagent (5 mg/ml) for 10 min, and then rinse in running tap water until free of basic fuchsin (4, 5). The tissue is now stained in toluidine blue O (1 mg/ml) buffered at pH 5.3-5.5 for 10-20 min, then rinsed in running tap water, air dried and mounted in Bio-mount (J. E. Halma Company).

A photomicrograph of cleavage metaphase chromosomes is shown in Fig. 1.

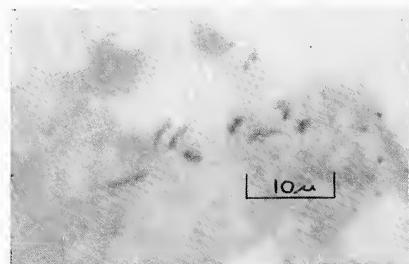


FIG. 1—Chromosomes (2n) of haplo-diploid anoetid mite *Anoetus laboratorium* (3). 2100X.

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Communications and Reports

VIRGINIA ACADEMY OF SCIENCE

Summary of Council Meeting*

October 27, 1968

Council met on Sunday, October 27, 1968 at Washington and Lee University, Lexington, President Siegel presiding.

Ad Hoc Committees

Three Ad Hoc Committees have been appointed by the President: 1) Committee on Structuring of the Life Science Section, chaired by Charles Hammer, 2) Committee on Executive Officers, chaired by W. Bell, 3) Museum of Science Committee, chaired by E. S. Harlow. The latter committee was appointed in response to a request by R. D. Hughes, a member of the Study Commission appointed by Governor Godwin.

Science Advisory Group

President Siegel reviewed activities directed toward establishment of a Science Advisory Group to the Governor. A meeting with the Governor's assistant, Mr. Archer Yeats and officers of the Academy was held on September 30.

Future Meetings

Recommendations of the Executive Committee regarding times and places of the annual meeting of the Academy through 1973 were considered and approved. In the last five years Academy membership has grown from 1,000 to 1,700 members indicating that the present size makes it extremely difficult for any hotel in the state to provide all the meeting rooms for the Academy's annual meeting. With the understanding that a possible alternative meeting place for the Junior Academy might still be arranged, the motion to adopt the recommendations of the Executive Committee was approved. The chairman of the Long Range Planning Committee was directed to begin discussions of appropriate meeting places after 1973.

E.C.L. Miller Award

Action of the Executive Committee endorsing presentation of the Miller Award to the Science Club rather than to the sponsor was noted. This recommendation continues a practice of long standing.

Academy Charter

Amendment to the Charter was signed by the President and Secretary bringing the Charter into line with actual current practices of the Academy.

* Abbreviated by the Editor from minutes provided by the Secretary, Edward F. Turner, Jr.

Negus Memorial Lecture

President Siegel reported that he had secured Professor William J. L. Sladen, Department of Pathobiology, Johns Hopkins University, as the Sidney S. Negus Memorial Lecturer for the Annual meeting in 1969. Dr. Sladen's topic will be "Adult and Juvenile Behavior of the Adelie Penguin." It was requested that the speaker be reminded that his paper must be submitted for publication in the *Virginia Journal of Science*. A copy of the format requirements for submission to the *Journal* will be sent him.

Inaugurations

Mr. Siegel attended the inauguration of President Huntley of Washington and Lee University on October 18, and Mr. Berry attended the inauguration of President White of Randolph-Macon College on September 28 as representatives of the Academy.

Memberships

Efforts are continuing to determine the feasibility and cost associated with putting the membership roll of the Academy on a computer. In response to a request by the Finance Committee the President prepared a letter to be mailed with the current billing of membership dues.

Visiting Scientist Program

All but two of the forty-four colleges solicited for their cooperation responded affirmatively. The two colleges unable to participate expressed sympathy for the program and cited staff difficulties as their reason for non-participation. President-elect Carpenter presented a written report containing guidelines for operation of the program and an extensive list of speakers and their topics. He reported that over 400 requests have been received for this list. Copies may be secured by writing Mr. Carpenter. Council approved a resolution by R. D. Hughes commending President-elect Carpenter for his work on the Visiting Scientist Program.

Local Arrangements for 1969 Meeting

President-elect Carpenter submitted names of the Local Committee on Arrangements for the 1969 meeting at Mary Washington College in Fredericksburg and the report of the Exhibits Committee. He also submitted a proposed program for the meeting and a proposed agenda for the academy conference. Mr. Russell requested that the program show explicitly the meeting time and places for the Science Talent Search interviews and for the Science Talent Search luncheon. It was agreed that these would be scheduled for 8:30 a.m. to 12:00 p.m. and at 12:15 p.m. respectively. Interviews are scheduled to take place in the offices of the Science Building. It was agreed that attempts would be made to arrange for

the luncheon at the Hot Shoppe. Mr. Wisman raised a question about the scheduling of the VJAS top paper in the individual sections at 2:00 p.m. on Friday, pointing to the fact that this causes a late arrival at home for junior participants. Mr. Wightman observed that sometimes there is not a VJAS paper from every section and that consequently this leaves a hole in the programming of the section's meeting. Both these points were discussed at length with the conclusion that the proposed time was probably the best. Mr. Carpenter then reviewed the agenda for the conference. Mr. Harlow objected to the proposal that no oral reports would be made by committee chairman during the conference. He suggested that, because of the interest of the members in the Academy's affairs, time should be allowed for brief oral reports of about a minute each from the chairmen of standing committees who should confine their report to important and significant items. It was agreed that this matter would be left to the judgment of the President, it being the sense of Council that some time should be allotted for an oral review of significant work done by the standing committees. It was requested that chairmen of committees submitting written reports be asked to make them as brief as possible, consistent with the necessity to report fully, in view of the fact that these reports are published in the *Journal*. Beginning with the 1970 meeting no Saturday sessions will be scheduled for any of the sections. The 1969 meeting is a transition between the current and proposed schedules. The proposed program and conference agenda as modified by these discussions was adopted. It was suggested that the conference agenda be published with the program.

Treasurer's Report

Treasurer Rowe submitted his report to the Council for the third quarter. He remarked that the Academy was operating within its budget and was in sound financial condition.

Executive Secretary-Treasurer Report

Mr. Berry reported that the membership now stands at 1755, compared with 1606 at the close of last year. 116 have not paid 1968 dues. There are twenty-two life members, patrons and others who receive the *Journal* without charge. Two of the business members of the Academy did not renew their membership and thirty-five colleges in the state are institutional contributors.

VJAS

The VJAS plans to operate much the same kind of program as last year. The current budget called for \$5,300 for next year, compared to \$10,000 for the current year. The VJAS budget request was for \$6,200, the reduced budget request reflecting elimination of student and teacher subsidies. Mr. Wisman did not anticipate a serious deleterious effect on the program as a result of elimination of subsidies, but expressed concern at the deeper budget cut. He reported that the Academy might be the recipient of

a \$2,000 grant from NSF in support of the VJAS program.

Long Range Planning Committee

The Long Range Planning Committee met in Charlottesville, Sunday, October 14. The committee discussed what the Academy might do to contribute to upgrading of science programs in the primary and secondary schools of Virginia. It plans to have representatives from the science teachers in the high schools at its next meeting. Mrs. Vera Remsburg cautioned the committee to move slowly about making recommendations for the Science Teacher's Section in the Academy because of moves already under way by the science teachers.

Membership Committee

The committee has prepared new faculty lists. Letters have been sent to various Academy members in a number of colleges asking them to assist in soliciting new members. Chairman Hughes asked for help in compiling a list of all industrial scientists and engineers in the state. Miss Virginia Ellett is preparing a list of Science Teachers.

The committee has taken action with respect to the proposal to establish a new class of Academy membership, the "Fellow." President Siegel reminded Council that final implementation of the report could come only after a constitutional change. In response to a question as to whether "Fellow" would be a special class with respect to dues, Mr. Hughes said the committee recommended that it would not.

Publication Committee

Mr. Flory reported that the committee's chief responsibility was with the *Journal*. He reviewed the events of the past year beginning with Mr. McKenney's resignation and Mr. Abbott's appointment as Editor of the *Journal*, citing the committee's feeling that an orderly transfer had occurred. He cited the main problem as being one of finances, indicating that current year expenses are likely to exceed the budget appropriation by \$3,000. The financial problem prompted serious questions about support of the *Journal*, and a meeting of the committee for later in the day was called to deal with this general question.

With reference to the Dismal Swamp Manuscript, Mr. Flory reported that progress was being made in securing manuscripts.

Research Committee

In the absence of Chairman Hobbs, Mr. Siegel read the report of the Research Committee.

Trustee Report

No changes have been made in the Academy's investments. The Academy's endowment now stands in the neighborhood of \$45,000.

In response to a query from Mr. Berry regarding the possibility of transferring \$650 from endowment to support publication of the history, Mr. Harlow

said he would not favor a transfer from endowment for this purpose at this time.

Virginia Journal of Science

The Editor expressed his pleasure at the "fine state of excellence" of the Journal when he assumed responsibility for it. "We can be proud of it," he said and we "want to maintain it." He cautioned it will probably cost more money than formerly. He reminded those present that page ads in the Journal cost only about \$400 for all four issues of one year and expressed his conviction that this was sufficiently inexpensive to attract more advertisers. He requested help from all members in selling ads.

Finance Committee

In the absence of Chairman Harshbarger, President Siegel presented the report of the Finance Committee. In response to a question Mr. Harlow said the needs of the Academy, other than the Journal and the VJAS were successfully met in the proposed budget. The report was adopted.

Section Reports

Engineering. Mr. Ragone reported that the Engineering section had met on October 23.

Geology. Mr. Harshberger reported the Geology section had discussed the possibility of field trips to be held during the 1969 Annual meeting.

No report was forthcoming from other sections.

Science Talent Search

Mr. Russell called attention to an earlier distribution of material about the work of the committee. He stressed that all Virginia participants in the Westinghouse competition are automatically reviewed by the committee, and no special application is required in these cases.

Flora Committee

Mr. Harvill reported that the Flora Committee is looking toward publication of a 400 page book on Virginia Flora in about three years. He estimated that the book would cost about \$6,000 for 1000 copies. After some discussion Council expressed its sympathetic interest in the project and referred the matter to the Publications Committee for further exploration with the Flora Committee.

Restructuring of Life Science Sections Committee

The following proposal of the *Ad Hoc* Committee was presented.

"The *Ad Hoc* Committee proposes the following restructuring of the life sciences sections of the Virginia Academy of Science in order to create more interest in the life sciences sections, to better define the sections and to have a coherent series of papers which are more evenly distributed between the sections.

We propose to update the titles of the present life science sections by introducing four new titles with more specific connotations in place of the four present titles which are too broad (medical sciences) on

one hand and too narrow (microbiology) on the other. These four new titles are tailored and defined to include all interests of the membership that are in the present section.

1. Anatomical and Developmental Biology

This section would include research papers involving studies ranging from gross anatomy through ultrastructure to biochemical events during development of plants and animals. The areas of embryology, gerontology, genetics, entomology, histology, cytology, etc. would be typical examples of interest areas.

2. Systematic and Ecological Biology

Papers concerning behavior and interactions or organisms in their totality or a specific unit of function to their environment and treatment would be included in this section. Interest areas would include the agricultural scientist, taxonomist cellular, organismic and population biologist working in ecology.

3. Biochemistry and Physiology

The title of this section is self-explanatory and is to include all basic research papers in the areas of nutrition, molecular biology, physiology and microbiology which do not concern developmental or ecological biology.

4. Clinical Medicine, Pharmacology and Pathology

This section is to include all papers of a clinical nature. It includes pharmacology and pathology because of its close association with the clinical medicine departments."

Mr. Hammer, chairman of the *ad hoc* committee expressed the view that the changes would provide a more even distribution of papers, and a more homogeneous grouping of interests among the section members, and suggested the change, if adopted, should take place at the 1970 annual meeting.

Objections were entered by Messrs. Abbott, Hughes and Clarke. Mr. Abbott questioned the advisability of Council reorganizing sections by fiat, noting that, in the past, sections had organized themselves. Mr. Hughes, responding to the point that the Microbiology section had suffered poor attendance, noted that for the past several years, the Academy's annual meeting had conflicted with the national meeting of Microbiologists.

The following motion was passed:

"Moved, that the Committee on Restructuring of Life Science Sections be commended for their work. Realizing that sections are autonomous, Life Science sections should be polled by a questionnaire on the subject of restructuring."

Museum of Science Committee

Mr. Harlow reported there had been one meeting of the large committee and that a subcommittee had been appointed and had met. Work to date had been toward preparation of a first statement to the commission.

Nominating Committee

Suggestions for nominations for Academy Offices were solicited.

Business Advisory Committee

Mr. Gladding, reporting for Mr. Irby, solicited information on key people who could assist in recruitment of business members of the Academy.

SCHEDULE OF DEADLINES AND RESPONSIBILITIES FOR THE 1969 ANNUAL MEETING VIRGINIA ACADEMY OF SCIENCE

February 28: MEMBERS to CHAIRMAN OF RESEARCH COMMITTEE. Three copies of papers for Horsley Award competition. Send title to SECTION SECRETARY.

March 13: SECTION SECRETARIES. Where warranted, a call or letter to chairmen of departments of those institutions reminding them of deadline of papers.

March 22: MEMBERS to SECTION SECRETARIES. Titles of papers for presentation at annual meeting. Include titles of any paper entered in Horsley Award competition.

April 1: SECTION SECRETARIES to PRESIDENT-ELECT. Copy of section program in final form for direct printing by photo-offset. SECTION SECRETARIES to CHAIRMAN OF LOCAL ARRANGEMENTS COMMITTEE. A list of equipment and space needs for their section at the annual meeting. SECTION SECRETARY TO EXECUTIVE SECRETARY-TREASURER. Names and addresses of those presenting papers in his section.

April 9: DIRECTOR VJAS to PRESIDENT-ELECT. VJAS program in final form for printing by photo-offset.

April 12: PRESIDENT-ELECT to PRINTER. Copy of VAS-VJAS program.

April 23: EXECUTIVE SECRETARY-TREASURER to ALL MEMBERS. Copy of printed program. Three copies of abstract forms and instructions for their use sent to members presenting papers.

April 30: MEMBERS to SECTION SECRETARIES. Three copies of abstracts in final form for publication in the Virginia Journal of Science.

May 9 or 10: SECTION SECRETARIES to EXECUTIVE SECRETARY-TREASURER. Names and addresses of section officers for 1969-70, record of members and non-members attending section session, and abstracts of all papers presented in section.

PROPOSED CHANGE IN CONSTITUTION

The Membership Committee report on a new class of membership was approved by Council, October 27, 1968. This requires a constitutional *addition* which is given below. It would become ARTICLE 4 with the present ARTICLE 4 becoming 5 etc. This will be voted on by members at the Academy Conference, Friday, May 9, 1969. The Constitution and Bylaws were published in the summer (1968) issue of the Journal (Va. J. Sci., 19, 150 (1968).

ARTICLE 4: FELLOWS

From the active membership there shall be a body of scholars known as "Fellows of the Virginia Academy of Science," selected because of their contribution to science in one or more of the following ways: a) outstanding scientific research; b) inspirational teaching of science; c) highly significant leadership in the Academy.

Rules and Procedures: 1) A "Fellow" must be nominated by at least three members of the Academy. The Academy Council must approve each "Fellow" by a majority vote, and will establish the limiting date for receipt of nominations. It will be the usual procedure to announce new fellowships at an annual meeting. 2) No more than 25 fellowships will be approved the first year. After the first year, no more than $\frac{1}{2}$ of 1% of the total active membership shall be selected in any one year. The limiting number of active "Fellows" shall not exceed 5% of the total membership of the Academy. 3) All "Fellows" shall be presented with a suitably inscribed scroll. 4) Appropriate announcement of new "Fellows" shall be made in the Virginia Journal of Science.

News and Notes

STATE SCIENCE MUSEUM

The idea of a Virginia Museum of Science was enthusiastically embraced by a series of speakers at a public hearing held in Richmond, January 8, 1969. A total of 16 speakers brought endorsements of the science museum concept during a hearing of more than three hours by the State Museum of Science Study Commission. The five-member commission was created by the 1968 General Assembly to determine, among other things, the feasibility of establishing a state science museum.

Figures on the size of a tract for a state science museum were included in several speakers' presentations—figures that ranged from a few hundred acres to 1,000 acres. Room for parking, space for such things as a botanical garden and arboretum and room for future growth were stressed. There were several suggestions that the museum be located in the Richmond metropolitan area.

One of the major themes running through the presentations involved the educational value of a science museum. "Virginia needs a central museum of science," said Robert C. Haynes, director of the Mathematics-Science Center of Richmond Public Schools. Such a museum, he said, could cooperate with other agencies and institutions in the state to help raise the "scientific literacy" of Virginians in an age when science plays such an important role in society.

Dr. Austin E. Grigg, dean of Richmond College of the University of Richmond, said a science museum would have cultural benefits, and could expose a broad segment of the general public to science.

Charles H. Peple, representing the Robert E. Lee Council of the Boy Scouts of America, said a major mission of a science museum involves imparting knowledge. He indicated that a science museum would be beneficial to scouting programs. Scouts are particularly interested in archaeology, in natural sciences dealing with wildlife and plants, in space sciences and in oceanography, Mr. Peple said. He also noted trends toward increasing amounts of leisure time in society today, which is resulting in more and more people becoming interested amateurs in such fields as archaeology, paleontology, botany and astronomy. This means there is a need for "a guiding light" for such amateur groups, which a science museum could provide.

Thomas J. Ogburn, representing the Richmond Astronomical Society emphasized a need for a planetarium as part of a state science museum; Peter McCrery, representing the Richmond Gem and Mineral Society, suggested, among other things, that the proposed museum include facilities and opportunities for serious amateurs and professional scientists to conduct research.

Dr. Curtis M. Brooks of the University of Vir-

ginia, whose special interest is the history of science, noted the proximity of the Smithsonian Institution to Virginia, and urged that a Virginia science museum be complementary to the Smithsonian. Despite the nearness of the Smithsonian, there is a need for a Virginia science museum, Dr. Brooks said, to emphasize Virginia scientists and inventors, and to show the scientific developments now occurring in the state.

Two representatives of the Virginia Nurserymen's Association, W. W. Watkins of Midlothian and A. J. Shoosmith of Chester, urged inclusion of a botanical garden and arboretum.

At a previous public hearing held in Richmond, November 12, 1968, Dr. W. T. Sanger, chancellor emeritus of the Medical College of Virginia, urged the commission to consider a section devoted to the health sciences. Health matters occupy an important place in modern society, and experience from health science museums in other parts of the nation demonstrates a high public interest in health exhibits, according to Dr. Sanger, who spoke as a citizen rather than an MCV representative. Dr. Sanger stated there would be no trouble getting material for a health section in a state science museum. For one thing, he said, "almost every month, our two medical schools send off to medical meetings outstanding exhibits," but there is no place to put them when they are returned.

Edward S. Harlow, chairman of the Virginia Academy of Science's museum committee, said the academy has "had an abiding interest in a state science museum for years." It should be concerned broadly with the natural sciences and the applied sciences (such as agriculture and oceanography). Further, the academy believes it should contain educational facilities (such as meeting halls, a theater, a planetarium); research facilities, and repository facilities for collections of various sorts.

Col. Howard A. MacCord (U. S. Army-Ret.) of Richmond, said he has found a desire throughout the state for a science museum, with a repository for Virginia historical objects such as Indian relics. Col. MacCord is a historian-archaeologist staff member of the Virginia State Library, but said he, too, was speaking as a private citizen. He told the commission the size and scope of a state science museum "ought to be on the scale of the Virginia Museum of Fine Arts." The central operations should be in Richmond, he said, with adjunct facilities in major regions of the state, serviced by mobile units and lending exhibits.

Col. MacCord stated that he has visited all of Virginia's counties and has found wide-spread support for such a museum. Garden clubs, wildlife organizations, archaeological groups are among the numerous groups that he said have endorsed a state science museum.

HIGH SCHOOL STUDENTS SELECTED

Six Virginia high school students have been chosen to represent the State at the National Junior Science, Humanities and Engineering Symposium meeting next spring at West Point, N. Y.

The students were among 10 finalists, who reported on individual research projects in the life and physical sciences, when they attended the sixth annual Virginia Junior Science, Humanities and Engineering Symposium at the University of Virginia in December. Ten papers were chosen from about 30 submitted to a judging board of the University's School of Engineering and Applied Science.

Two students were awarded \$25 prizes for papers judged outstanding in the life and physical science categories. They are Annette L. Haines of John Handley High School in WINCHESTER for the life sciences and Paul M. Ford of Cradock High School in PORTSMOUTH for a paper in the physical sciences.

The other four students who will represent Virginia are Sherry L. Oliver of Liberty High School, BEDFORD; Edward B. Fischler of Woodrow Wilson High School, PORTSMOUTH; Michael Hurst of John Handley High School, WINCHESTER; and Charles Herzog of Thomas Jefferson High School in RICHMOND.

The symposium at the University of Virginia brought together about 220 scientifically minded high school juniors and seniors and 55 teachers from about 65 Virginia high schools.

Participants heard lectures, engaged in panel discussions, visited scientific and engineering facilities at the University and explored career opportunities.

The program was sponsored by the University's engineering school with support from the U. S. Army and the University's Alumni Fund.

MOUNTAIN LAKE SUMMER SESSION

The University of Virginia has announced the program of the graduate biology courses to be offered this summer at the Mountain Lake Biological Station in southwestern Virginia. They are as follows:

First Term—June 12 through July 15

Entomology: Dr. George W. Byers, University of Kansas

Ornithology: Dr. David W. Johnston, University of Florida

Plant Ecology: Dr. Frank McCormick, University of North Carolina

Vertebrate Endocrinology: Dr. B. E. Frye, University of Michigan

Second Term—July 17 through August 21

General Ecology: Dr. Maurice Brooks, West Virginia University

Invertebrate Zoology: Dr. Horton H. Hobbs, Jr., Smithsonian Institution

Mycology: Dr. Constantine J. Alexopoulos, University of Texas

Plant Biosystematics: Dr. C. Ritchie Bell, University of North Carolina

A limited number of National Science Foundation scholarships are available for research and study: (1) Post-doctorate for research, stipend \$1300; (2) Pre-doctorate for supervised research, stipend \$500; and (3) Post-graduate for training in field biology, stipend \$400. Preference is given for studies concerned with the biota of the region. Application blanks for these awards may be secured from the Director, Mountain Lake Biological Station, Department of Biology, University of Virginia, Charlottesville, Virginia 22903 and must be submitted before May 1, 1969.

General Notice To Contributors

The Virginia Journal of Science heartily welcomes for consideration original articles of technical or general interest on all phases of mathematics, the natural, physical and engineering sciences. Submission of an article for publication implies that the article has not been published elsewhere while under consideration by the Journal.

All articles should be typewritten (double-spaced) and submitted on good bond paper ($8\frac{1}{2} \times 11$ inches) in triplicate to the Editor. Margins should not be less than $1\frac{1}{4}$ inches on any border. Title, running title, authors, place of origin, abstract, figures, legends, tables, footnotes, and references should be on individual pages separate from the text. Technical abbreviations should follow consistent standard practices with careful avoidance of unnecessary neologistic devices. All pages (including illustrations) should be consecutively numbered in the upper right corner. A pencil notation of author names on the back of each page is helpful in identification.

Illustrations should be supplied in a form suitable for the printer with attention to the fact that a reduction in size may be necessary.

A good technical article generally contains an obligatory abstract before the text, an introduction, with reference to preliminary publications that may exist, an experimental section, results (which may be included in the experimental section), a discus-

sion, and conclusion. References are indicated in the body of the article by consecutively used numbers in parentheses. Although publication costs are high, attention should be given to relatively complete references (bibliographies) since the purpose of an article is to illuminate the significance of present and past findings, and not merely to obscure the past. The Journal reserves the right (generally exercised) to make page charges for articles in excess of 5 pages and to bill authors at cost for unusually complicated illustrative material.

Abbreviation of journals for references can be found in the 4th edition of the *World List of Scientific Periodicals*, Butterworth, Inc., Washington, D. C., 1963, and supplements. References should be checked carefully.

The form of presentation is illustrated below:

1. Aiyar, A. S., and Olson, R. E., *Fedn Proc. Fedn Am. Soc's exp. Biol.*, **23**, 425 (1964).
2. Chappell, J. B., Cohn, M., and Greville, G. D., in B. Chance (Editor), *Energy linked functions of mitochondria*, Academic Press, Inc., New York, 1963, p. 219.
3. Riley, G. A., and Haynes, R. C., Jr., *J. biol. Chem.*, **238**, 1563 (1963).

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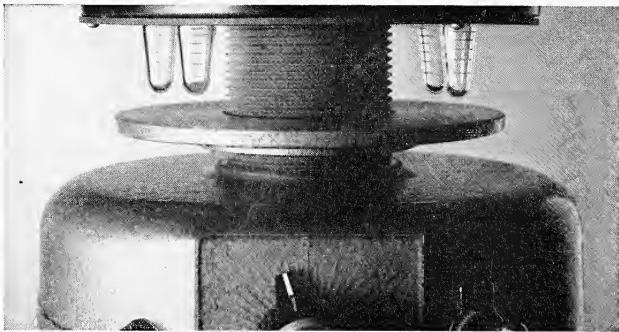
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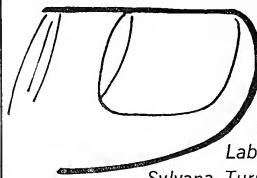
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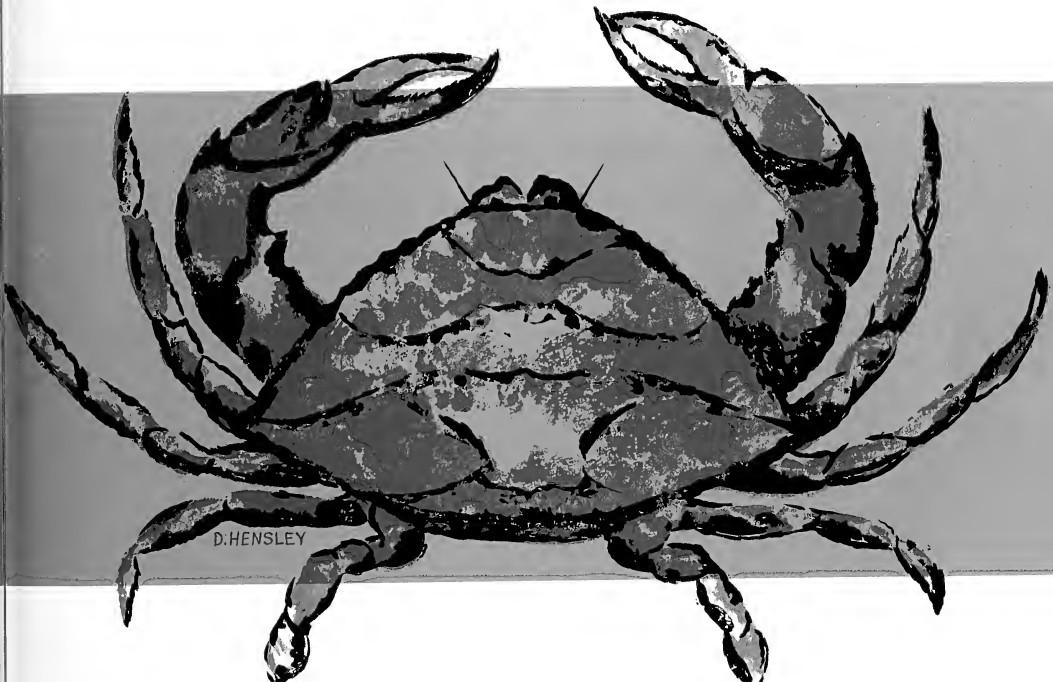
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The front cover is by Douglas C. Hensley.

Harold G. Marshall

Department of Biology
Old Dominion College
Norfolk, Virginia 23508

Received[†] June 5, 1967

Observations on the Distribution of Phytoplankton in the Elizabeth River, Virginia

Abstract—Nine hydro-stations were established along a 22 kilometer extent of the Elizabeth River, Virginia, to observe the composition of the phytoplankton populations and some corresponding chemical characteristics. *Skeletonema costatum* was the predominant diatom, with *Cryptomonas* sp., *C. salina*, and *C. stigmatica* the most numerous phytoflagellates. The river water's decrease in salinity was accompanied by a corresponding decrease in the diversity of phytoplankton species.

Introduction

The seasonal phytoplankton populations at two stations in the Elizabeth River have been discussed previously by Marshall (1). The luxuriant diatom communities of the fall and winter months are followed by more modest numbers of phytoflagellates that predominate during the warmer months of late spring and summer. The dominants of the winter and summer flora are *Skeletonema costatum* and several cryptomonad species respectively. In the present study, a comparison is made between the composition and distribution of phytoplankton at different stations over a 22 km distance in the Elizabeth River. The relationship of several species to the degree of fresh-water dilution is discussed.

Methods

Nine stations (E-1 to E-9) were established during high water in the Elizabeth River, between Craney Island and the locks at Great Bridge (Fig. 1). At each station, samples were taken at 3 m vertical intervals with a 2 liter Frautschy bottle on November 23, 1965. The number of vertical samples ranged from 4 at the mouth of the river to 2 at the Great Bridge station. Glass bottles were used to store 500 ml of the water samples, which were preserved immediately with a Lugol-Rodhe solution (2). After a settling period of 6 weeks, a siphoning procedure was followed until 10 ml concentrates remained. Five 0.2 ml portions of each concentrated sample were then examined on a microslide and phytoplankton identified by species in numbers of cells per ml of water (3-11). It should be noted that station numbers E-1 and E-2 have been reassigned to new sta-

tions in this study, since they were used previously by Marshall (1).

Additional 500 ml samples of water were taken from each station and filtered through type PH millipore filters into polyethylene bottles. Sodium, magnesium, and calcium concentrations were measured with a Perkin-Elmer 303 Atomic Absorption Spectrophotometer. Salinity and corrected temperature readings were obtained on station with a RS5-2 portable salinometer. Hydrogen ion concentration was found with a Beckman Zeromatic pH Meter.

Results and Discussion

The diatoms varied considerably in numbers and composition between stations E-1 and E-9. The concentrations of diatoms and phytoflagellates for each of these stations are given in Fig. 2. There were 21 diatoms identified in the Elizabeth River with 14 species observed at stations E-1 and E-2. The most abundant forms in the study were: *Chaetoceros affinis*, *C. compressus*, *C. didymus*, *Rhizosolenia stolterfothii*, *Nitzschia seriata*, *Asterionella japonica*, *Ditylum brightwellii*, and *Skeletonema costatum*. The numbers of these species, with the exception of *S. costatum*, decreased at stations upstream. *S. costatum* increased steadily in numbers to represent 93% of the diatoms at E-9. There was a slightly greater concentration of diatoms in the deeper water samples at stations E-1 and E-2, with more homogeneity in distribution at the other stations.

Fourteen phytoflagellate species were present at stations E-1 and E-2. The majority of these declined in numbers at succeeding stations. However, the cryptomonads were present at all stations and were the most abundant flagellates from E-7 to E-9. The other common forms included: the xanthophyceans *Nephrochloris* sp. and *Olisthodiscus carterae*; one dinophycean *Peridinium* sp.; two desmophyceans *Exuviaella* sp. and *Prorocentrum micans*; and five cryptophyceans *Chroomonas vectensis*, *Cryptomonas* sp., *C. salina*, *C. stigmatica*, and *Rhodomonas amphioxenia*. Several unidentified green cells, irregular in shape, 3-5 microns in size, were also found in the less saline water samples. The vertical concentrations of the phytoflagellates were approximately the same

[†] Revised August 16, 1967.

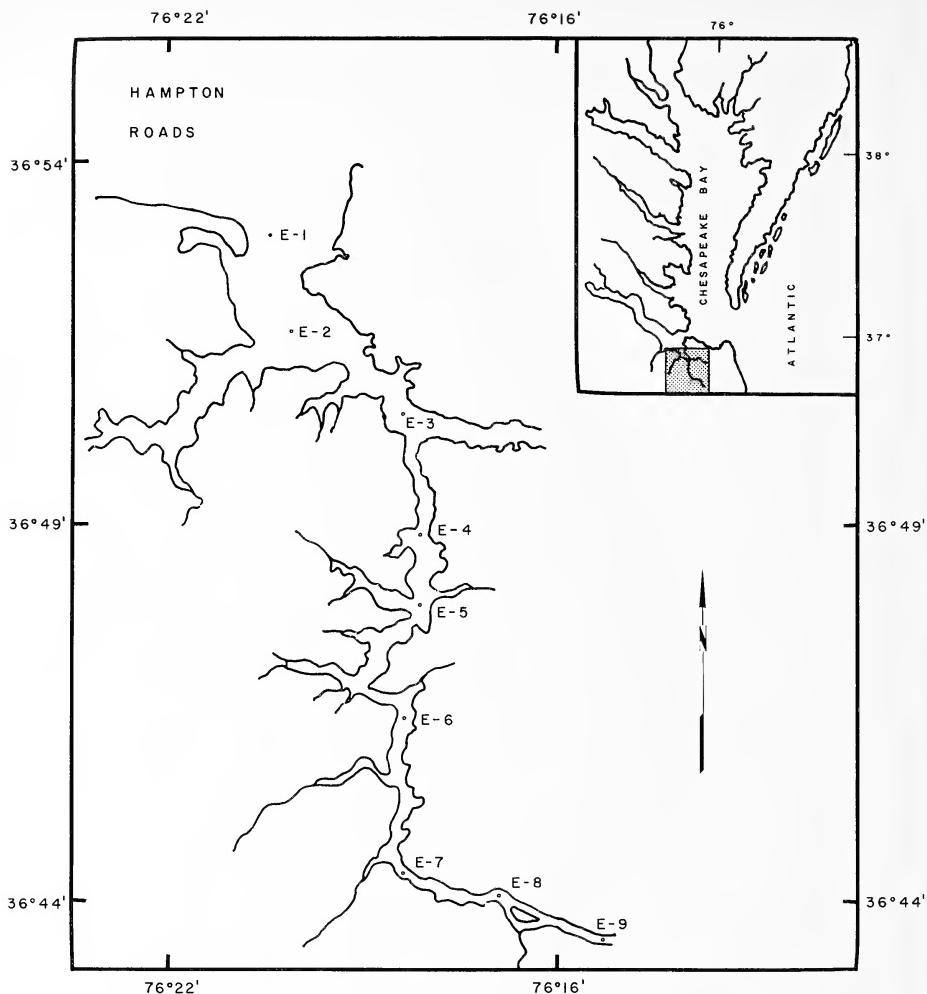


FIG. 1.—Station locations in the Elizabeth River. The distance between Stations E-1 and E-9 is 22 km.

at stations E-3 to E-9, with larger quantities in the upper 6 meters at E-1 and E-2.

The numbers of *S. costatum* did not approach the high concentrations found by Marshall (12) in the more saline waters of nearby Hampton Roads and Willoughby Bay. During this 18 month study, this species reached counts of at least 100 cells per ml in the majority of water samples, with largest concentrations occurring during the colder months. The phytoplankton populations along a 140 mile collec-

tion series in the Chesapeake Bay indicated a reduction in *S. costatum* up the Bay, accompanied by increased numbers of the cryptomonads (13). The most common phytoflagellates in the present study were neritic and estuarine species. The phytoflagellates exhibited a wider range of distribution and diversity upstream than the diatoms. *Ceratium furca* and *Exuviaella marina* were two oceanic forms found only at stations E-1 and E-2. The diatoms were mainly neritic, north temperate species (11). Fresh-

TABLE I
Results of Water Analysis from Surface Samples at Mid-Channel Stations in the Elizabeth River on November 23, 1965

Station	Hrs.	°C	pH	Concentrations in ppm			Salinity ‰	No. cells/ml	
				Ca	Mg	Na		Diatoms	Phytoflagellates
E-1	1115	10.88	7.69	1320	874	7270	24.12	37	24
E-2	1144	11.15	7.81	1320	871	7130	23.59	31	20
E-3	1208	11.52	7.50	1280	859	6900	23.39	6	30
E-4	1230	12.52	7.38	1280	830	6740	22.61	3	16
E-5	1252	13.12	7.32	1130	806	6420	21.60	2	13
E-6	1338	16.52	7.14	1120	761	6300	20.72	7	17
E-7	1401	13.30	7.28	940	630	5080	17.41	10	6
E-8	1415	12.97	7.21	880	579	4840	16.54	35	12
E-9	1430	12.58	7.16	830	537	4540	15.15	55	22

water types were rare and no true oceanic diatoms were found.

The reduction in the number of phytoplankton species was accompanied by an increase in marine and fresh-water mixing along the Elizabeth River to station E-9. The degree of dilution was indicated by the decreasing concentrations of cations and salinity along the station route. Salinity increased with depth at all stations. The surface sodium and magnesium values (Table I) were below those usually found in open sea water (14). The concentrations decreased proportionately upstream in relation to the lowered salinity values from E-1 to E-9. The calcium concentrations were above those found in sea water at all the stations and declined from the mouth of the Elizabeth River (E-1) inland to Great Bridge (E-9). This is in contrast to the results of Price and Gunter (15) who emphasize the gradual change in the ratio between calcium and magnesium

The values for calcium and magnesium decreased in the present samples, but their ratio remained rather constant, between 1.4 and 1.5. These values are no doubt influenced by the fossil beds, land drainage, and the present relicts from oysters in the James River estuary.

Summary

The composition of phytoplankton did not change abruptly along the Elizabeth River; instead there was a steady reduction in the number of species at successive stations upstream. A decrease in the total numbers of diatoms occurred from E-1 to E-5, then the numbers increased to reach the series maximum at E-9 (55 cells/ml). In the samples taken from stations E-6 to E-9, there was a continued increase in the proportion of *S. costatum* to the numbers of other diatoms. The lowest concentration of phytoflagellates was at station E-7, and was followed by increasing numbers of cryptomonads at E-8 and E-9.

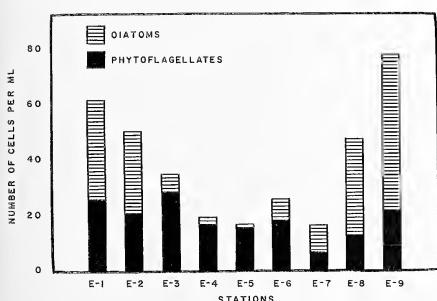


FIG. 2.—Concentrations of diatoms and phytoflagellates at stations in the Elizabeth River (E-1 to E-9) on November 23, 1965.

as the estuarine water suffuses the out-going water in a river system. They cite a ratio increase from 0.31 to 2.0 going from sea water to fresh water.

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Plankton Distribution in a Small Virginia Reservoir

Abstract—It was the purpose of this study to measure the abundance and diurnal changes in vertical distribution of plankton in a small Virginia reservoir during the winter and spring months. Sampling was carried out during ten 24-hour periods from November to May. Overall, the plankton was found to be randomly distributed, with a slightly larger number present somewhat below the surface stratum; several species exhibited a tendency toward a patchy distribution. Diatom species were the most abundant form during the months of this study. Correlations between plankton distribution and physical-chemical properties of the reservoir were inconclusive. There was no consistent evidence of a daily variation in vertical distribution by any of the plankton species.

Introduction

The objectives of this study were to measure the abundance and diurnal changes in vertical distribution of plankton in Swift Creek Reservoir during the winter and spring months. There have been several plankton distribution studies in the western portion of Virginia, but there have been few studies, especially dealing with zooplankters, in the Piedmont region of the state. Woodson (1, 2) and Woodson and Holoman (3, 4) have investigated the distribution and ecology of phytoplankton over a portion of this region, but studies on vertical distribution, as well as diurnal characteristics of this distribution, are lacking.

Numerous workers have noted, and made attempts to explain, vertical movements by various zooplankters. Studies have shown that vertical migration is highly variable from lake to lake and from species to species. Langford (5), Pennak (6) and Cushing (7) have reviewed the vast amount of literature concerning this problem.

Fogg (8) has shown that the vertical distribution of phytoplankton may be quite patchy. The study of Mountain Lake, Virginia, by Grover and Coker (9) supports this contention; they counted 1,508 colonial Chlorophyceae from surface samples, 538 at a depth of 0.61 m, and 2,115 at a depth of 1.52 m. Yeatman (10) found *Pithophora kewensis* and *Fragilaria crotonensis* concentrated at the surface and at 3.5 m, with much fewer numbers at the in-between depths.

There is little research to support a belief in vertical movements by chlorophyll-bearing plankters

(11). Pennak (6) noted *Ceratium* sp. may exhibit limited vertical movements, and phototropic responses by motile algal forms are well known. Dr. Lowell E. Noland (personal communication) has noticed phototropic behavior by *Zoochlorella*—bearing ciliates of the genus *Prorodon*.

Description of the Reservoir

The impoundment behind the concrete dam on Swift Creek in Colonial Heights, Virginia, was the site of this investigation. The reservoir, formerly used as a city reservoir, occupies an area of about 2 hectares and has a fairly uniform central depth of about five meters. The bottom drops abruptly from the shore so there is very little in the way of a littoral zone. The higher aquatics and semi-aquatics noted included *Juncus acuminatus* Michx., *Myriophyllum verticillatum* L., *Justicia americana* (L.) Vahl, *Saururus cernuus* L., *Podostemum ceratophyllum* Michx., *Pontederia cordata* L., and *Impatiens capensis* Meerb.

Prior to its entrance into the reservoir, the water of Swift Creek meanders in a southeasterly direction through Powhatan and Chesterfield Counties. The bedrock of this region is largely granite, and the soil is of a residual granite nature. The location of the reservoir, lat., $37^{\circ} 16' 15''$ N and long. $77^{\circ} 25' 9''$ W, places it near the eastern edge of the Piedmont region. Its elevation is about sixty feet above mean sea level. The water is quite brown and there is a muddy sandy-clay bottom. Samples taken from this water in the study by Woodson and Holoman (3) contained 54.6 ppm Ca, 0.55 ppm P, and no evidence of Mg, N, or K according to the tests used.

Materials and Methods

The quantitative sampling method employed was the sampler-and-net procedure. A modified Kemmerer sampler was used in conjunction with a number 25 plankton net to collect the plankton from 12 liters of reservoir water at each depth sampled. (No attempt was made in this study to sample for the smaller nanoplankters.) Samples were taken from a location near the center of the reservoir. On the first four sampling dates, samples were taken from three different depths at six hour intervals. On subsequent sampling dates, samples were taken from five different depths at twelve hour intervals.

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In addition to making plankton counts of the samples, various physical and chemical data were recorded. Each sampling time, air and water temperature, Secchi-disk visibility depth, above-surface illumination, and wind velocity were recorded. At each depth sampled, standard techniques (12) were used

to measure hydrogen ion concentration, dissolved oxygen, alkalinity, and free carbon dioxide.

Results

Table I shows the relative abundance of organisms on each of the sampling dates without regard for

TABLE I
Plankton in Reservoir with their Relative Abundance on Each Sampling Date

Species	11/3/67	11/18/67	11/25/67	12/1/67	12/5/67	1/30/68	3/9/68	3/23/68	4/2/68	4/6/68
CYANOPHYTA										
<i>Anabaena affinis</i> Lemm.	R	—	—	—	—	—	R	R	—	—
<i>Chlorococcus limneticus</i> Lemm.	—	R	—	—	—	—	—	—	R	—
<i>Gloeoctysis ampla</i> (Kuetz.) Lag.	R	—	R	—	—	—	—	—	—	—
<i>Microcystis aeruginosa</i> Kuetz.	S	R	—	—	—	—	—	—	—	R
<i>Spirulina major</i> Kuetz.	—	R	—	—	—	—	—	—	—	—
CHLOROPHYTA										
<i>Actinostroma Hantzschii</i> Lag.	S	R	—	—	—	—	—	—	—	R
<i>Closterium acerosum</i> (Schränk)	—	S	R	—	—	—	—	—	S	S
Ehren.	S	S	S	R	—	—	—	—	R	S
<i>Cl. moniliforme</i> (Bory.) Ehren.	S	S	S	R	—	—	—	—	R	S
<i>Cosmarium baccatum</i> Scott & Gronbl.	S	—	—	—	—	—	—	—	—	R
<i>Desmidium Grevillei</i> (Kutz.) D. Bg.	S	—	—	—	—	—	S	S	S	S
<i>Euastrum elegans</i> Breb.	R	—	—	—	—	—	R	—	—	—
<i>Golenkinia radiata</i> Chod	S	S	R	—	R	—	—	—	—	—
<i>Micrasterias radiata</i> Hass	S	—	—	—	—	—	R	R	S	S
<i>Pediastrum duplex</i> Meyen	S	S	—	—	—	—	R	R	R	S
<i>Scenedesmus quadricauda</i> (Turp.) Breb.	R	S	S	—	—	—	—	R	—	R
<i>Staurastrum paradoxum</i> Meyen	S	S	R	—	—	—	S	S	S	S
<i>Triploceras gracile</i> Bail	—	—	—	—	—	—	—	R	—	R
<i>Volvox aureus</i> Ehrenberg	M	M	M	M	M	S	S	S	R	R
<i>Zoochlorella parasticta</i> Brandt	R	—	R	M	S	—	—	S	S	S
EUGLENOPHYTA										
<i>Euglena oxyuris</i> Schmarda	S	R	—	—	—	—	R	S	S	S
<i>Trachelomonas acanthostoma</i> (Stokes)	R	R	—	—	—	—	—	—	—	—
PYRROPHYTA										
<i>Ceratium hirundinella</i> (O. F. M.) Duj.	R	S	S	—	—	—	—	—	—	—
CHRYSOPHYTA										
<i>Asterionella formosa</i> Hassal	A	A	A	A	A	S	R	—	R	R
<i>Chrysosphaera longispina</i> Laut.	S	S	—	—	—	—	—	—	—	—
<i>Dinobryon divergens</i> Imhof	R	M	M	M	S	M	M	R	R	R
<i>Eunotia pectinalis</i> (Kutz.) Rabenh.	—	—	—	—	—	M	—	—	—	—
<i>Mallomonas caudata</i> Iwanoff	A	A	A	M	M	M	S	R	—	—
<i>Melosira varians</i> Ag.	S	—	—	—	—	—	—	—	S	S
<i>Navicula</i> sp.	R	S	—	—	—	S	—	—	—	—
<i>Surirella saxoniae</i> Aversaw	S	—	—	—	—	—	R	S	S	S
<i>Synura wella</i> Ehrenberg	M	M	M	S	S	R	R	S	S	S
<i>Synedra</i> sp.	R	M	M	M	S	S	R	R	S	R
<i>Tabellaria fenestrata</i> (Lyngb.) Kutz.	S	R	—	—	—	S	S	M	M	M
<i>Tribonema bombycinum</i> var. <i>tenue</i> Ha.	A	A	A	A	A	S	S	M	M	M
CILIATA										
<i>Stentor polymorphus</i> (Muller) Oken	R	—	R	M	S	—	—	—	S	S

TABLE I (Continued)

Species	11/3/67	11/18/67	11/25/67	12/1/67	12/5/67	1/30/68	3/9/68	3/23/68	4/2/68	4/6/68
ROTATORIA										
<i>Branchionus angularis</i> Gosse	—	R	S	—	—	—	—	S	S	S
<i>Kelliecottia bostoniensis</i> (Rousselet)	S	S	S	S	S	R	M	M	M	A
<i>Keratella cochlearis</i> (Gosse)	S	S	R	R	R	R	M	M	M	M
<i>Testudinella</i> sp.	—	—	—	—	—	—	R	S	S	S
CLADOCERA										
<i>Bosmina longirostris</i> (O. F. M.)	S	S	M	S	M	S	S	S	S	S
<i>Daphnia galeata mendotae</i> Birge	—	—	S	—	—	—	—	—	—	R
<i>D. pulex</i> (deGeer)	M	M	M	M	M	S	S	M	M	M
COPEPODA										
<i>Diaptomus pallidus</i> Herrick	M	M	M	M	M	S	M	M	M	M
<i>Tropocyclops prasinus</i> (Fischer)	R	—	—	—	—	—	R	M	M	M
OTHER ARTHROPODA										
Ostracoda sp.	R	—	—	—	—	—	R	R	S	S
Culicidae larvae	—	—	—	—	—	—	R	—	S	R

A = abundant
(above 100/liter)M = moderate numbers
(above 10/liter)S = scarce
(above 1/liter)R = rare
(below 1/liter)

the depth at which they occurred. No attempt was made to interpret data on depth distribution for those organisms whose population density was below 10 per liter. Fig. 1 and 2 show graphically data collected from selected 24-hour studies. The simplified method of graphic representation used by Yeatman (10) was followed rather than the quartile method introduced by Pennak (13).

Fig. 1 shows a comparison between abundance of total zooplankton and total phytoplankton for the diel study of December 1, 1967. The zooplankton population showed very little variation in vertical distribution during the 34-hour period. The largest concentration each sampling time was taken from the 2 meter depth, an average of 50 zooplankters per liter; while the smaller surface and 4 meter popula-

tions, an average of 39 per liter and 40 per liter respectively, were quite similar.

The phytoplankton, all chlorophyll-bearing plankters, exhibited a similar maximum abundance at the 2 meter depth, as shown in Fig. 1, with relatively similar surface and 4 meter organism densities. The majority of the phytoplankton on this date belonged to the two species mentioned in Fig. 1, i.e. *Tribonema bombycinum* and *Asterionella formosa*. The similarity between their distribution and total phytoplankton distribution in Fig. 1 indicates how much their presence affected total phytoplankton distribution records.

Fig. 2 shows the vertical distribution record for two colonial flagellated phytoplankters on November 18, 1967. These data, taken by themselves, might erroneously suggest vertical migration by these forms. However, after further vertical sampling, and sampling to determine horizontal dispersion, a very marked horizontal and vertical patchiness in distribution was noted for these motile colonial forms. Another commonly observed colonial flagellate, *Syrnura uvella*, also exhibited a similar patchiness in its distribution characteristics.

Table II illustrates the type of data that was used to test for dependence between sampling time and

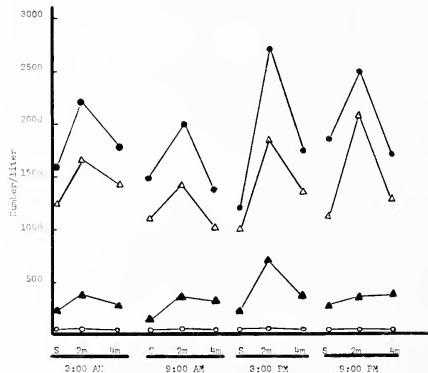


FIG. 1—Comparison of total zooplankton (○) with total phytoplankton (●), and the two most abundant phytoplankton species present on December 1, 1967, i.e. *Tribonema bombycinum* (▲) and *Asterionella formosa* (△).

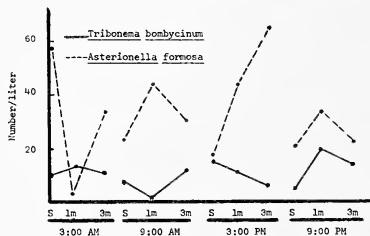


FIG. 2—Record of two colonial flagellate phytoplankters on November 18, 1967.

depth distribution. The chi-square statistic was used as the test statistic with 6 degrees of freedom. The calculated chi-square value for the data in Table II is 6.51, indicating no evidence of dependence between these two parameters. Similar calculations were made for other plankton organisms in abundance over 10 per liter; no species showed consistent evidence of dependence between sampling time and depth distribution.

The physical and chemical data from each of the 24-hour studies indicated little variation at different depths, probably due to continuous circulation of water within the reservoir. The most significant temperature difference between bottom water and surface water was 3.5°C during any one 24-hour period. The average mid-day Secchi-dish depth was only 1.3 meters. This is the depth at which there is generally about 5% of the above-surface illumination (14).

Variations in the water chemistry with depth were usually very small. A general tendency towards a higher carbon dioxide level and lower pH in the bottom waters was noted, and usually during the daylight hours the amount of free oxygen was high while the carbon dioxide was somewhat lower than at night. There were some easily recognized changes in water chemistry between the first diel study and the last. There was a gradual decrease in the pH, from a high of 7.3 to a low 6.4, and the alkalinity level was reduced from 30 ppm to 15 ppm. During the early sampling dates in April, these values began to rise again somewhat.

Discussion

When looking for correlations between physical and chemical factors which might affect plankton distribution, it is important that one does not confuse the cause and effect relationships. For example, if one found a great abundance of phytoplankton during the daytime at a depth characterized by abundance of oxygen, little carbon dioxide and alkaline reaction, and with a larger amount of calcium carbonate than at other depths, one might hastily conclude that such phytoplankton was present at that depth because such conditions were ideal for its existence and reproduction. Actually in most cases the phytoplankton was not seeking these conditions but was rather the cause of them.

The general trends mentioned in the preceding paragraph were noted in this study; however, correlations between physical or chemical factors and plankton distribution were inconclusive. The lack of significant diurnal variation in plankton distribution, as well as the relatively minor differences in water chemistry at different depths, meant that it was not possible to correlate plankton population densities accurately with the various physical and chemical data obtained. Lacking such correlations, one is forced to generalize and suggest, along with Ruttner (15), that water mixing was probably of greatest importance in determining the vertical distribution of the plankton in this relatively shallow reservoir.

TABLE II

Data for *Diaptomus pallidus* on December 1, 1967

Depth	Number per liter at the four sampling times			
	3:00 AM	9:00 AM	3:00 PM	9:00 PM
Surface	19	12	16	11
2.0 m	12	21	18	18
4.0 m	15	16	25	17

The seasonal variation in depth distribution or degree of vertical migration noted by Plew and Pennak (16) was not apparent during the six months of this study. The low abundance and general succession of planktonic organisms in this study agreed very closely to the findings of Whitford (17) for the brown-water lakes and ponds in North Carolina.

The absence of any observable vertical migration by motile planktonic forms is something that merits further consideration. The data for the most abundant copepod, *Diaptomus pallidus*, seemed to agree with the findings of Yeatman (10) in that this organism exhibited no apparent vertical migration. The diel movements for *Daphnia pulex*, *Bosmina longirostris*, and *Keratella cochlearis* noted by Pennak (6) in the transparent mountain lakes of Colorado were not characteristic of these organisms in the reservoir of this study. The possibility remains that a smaller vertical migration, especially near the surface waters, in the less transparent waters of this study was missed due to insensitivity in the sampling equipment employed.

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New Records of Virginia *Culicoides* (Diptera: Ceratopogonidae)

Abstract—New area records for four species of *Culicoides* are given, and breeding sites of these species are described in detail. *C. crepuscularis*, *C. haematopodus*, and *C. venustus* are reported for the first time from the Cumberland plateau area of southwestern Virginia, whereas *C. crepuscularis*, *C. haematopodus*, and *C. stellifer* are reported for the first time from the Piedmont plateau of central Virginia. The individual breeding sites are listed by counties.

Introduction

Members of the genus *Culicoides* are commonly referred to as "punkies", "no-see-ums", "biting gnats", "biting midges", and a variety of other less attractive synonyms. These tiny nematocerous flies must be considered noxious for two principal reasons: first, they have been associated with or incriminated as vectors of various pathogens, such as the filarial worms *Acanthocheilonema persians* (1) and *Mansonella ozzardi* (2), the protozoan *Haemoproteus nettionis* of ducks (3), *Leucocytozoon* spp. of domestic fowl (4), bluetongue virus of sheep (5), and the virus of eastern equine encephalomyelitis (6); secondly, these biting gnats are extremely bothersome to man and domestic animals because of their vicious, blood-sucking habits. In many areas they are more annoying than mosquitoes because they can penetrate ordinary mosquito screens. Many individuals show a particularly uncomfortable reaction to the bites of these pests (1, 2, 7).

One of the most common breeding sites for various *Culicoides* spp. is in wet mud containing leaf litter or other organic debris at the edge of a stream or pond. This generalized breeding site is typical of *C. crepuscularis* Malloch, *C. haematopodus* Malloch, *C. stellifer* (Coquillett), and *C. venustus* Hoffman (7, 8), the four species with which the present study is concerned.

Procedure

Suspected breeding sites were located, and 300–350 ml of the breeding substrate ($\frac{1}{2}$ " to 1" below surface level) were collected with a large spatula and placed inside a two-quart size waxed paperboard ice cream carton. This carton was wrapped with black polyethylene plastic to force the emerging adults to

fly upwards toward a light source. A smaller half-pint ice cream carton with a Saran cloth top was inserted through the lid of the two quart container to hold these adults. They were then collected from the smaller carton with the aid of a hand aspirator, and were placed in 80% ethyl alcohol until they could be identified. All collections were made in the summer of 1968.

Results and Discussion

Culicoides crepuscularis Malloch

New Records from this Study: Mecklenburg Co., July 18, dark mud at edge of Coleman Creek, U. S. 58, Boydton. Buckingham Co., July 18, wet mud at stream edge 4 miles east of Sprouses Corner, U. S. 60. Amherst Co., July 18, wet sandy mud at stream edge, 4 miles north of Amherst, U. S. 29. Campbell Co., July 19, weedy mud in drainage ditch 2 miles south of Lynchburg, U. S. 29. Tazewell Co., July 26, yellowish mud with slight vegetative growth at edge of roadside stream, 1 mile east of Cedar Bluff, U. S. 460. Buchanan Co., July 26, thick, wet mud at stream edge, Vansant, Va. 83.

Previous Records: Augusta (2, 9, 10), Craig (11), Franklin (12), Montgomery (8, 12), Roanoke (12), Rockbridge (12), Rockingham (12), Smyth (8), and Wythe (12) counties.

Discussion: These constitute the first records of this species occurring in the Piedmont region of central Virginia and in the Cumberland plateau region of the extreme southwest portion of the state. Previous records showed this species occurring only along a line following the Blue Ridge—Shenandoah Valley area of western Virginia. It would now appear that this species occurs in virtually all parts of the state.

C. haematopodus Malloch

New Records from this Study: Pittsylvania Co., July 18, sandy soil with decaying vegetation at edge of Pumpkin Creek at Danville city limits. Halifax Co., July 18, wet mud in run-off ditch at Winn's Creek, 14 miles west of South Boston, U. S. 58. Mecklenburg Co., July 18, same location as men-

tioned previously for *C. crepuscularis*. Lunenburg Co., July 18, wet mud at edge of stream flowing into Big Nottoway River, Va. 40. Nottoway Co., July 18, leaf litter at edge of Big Nottoway River, 6 miles south of Blackstone, Va. 40. Nottoway Co., July 18, sand and leaf litter, stream edge, 4 miles south of Blackstone, Va. 40. Prince Edward Co., July 18, wet mud at edge of Sandy River, 5 miles east of Farmville, U. S. 460. Cumberland Co., July 18, leaf litter at edge of Rock Creek. Buckingham Co., July 18, same location as mentioned previously for *C. crepuscularis*. Buckingham Co., July 18, mud at edge of Slate River, Va. 20. Albemarle Co., July 18, sandy, rocky mud at edge of Miller Creek, 2 miles west of Scottsville, Va. 6. Amherst Co., July 18, same location given for *C. crepuscularis*. Nelson Co., July 18, sandy moss-covered mud at stream edge, 3 miles south of Lovington, U. S. 29. Campbell Co., July 19, same location given for *C. crepuscularis*. Botetourt Co., July 23, mud at stream edge, 5 miles south of Clifton Forge, U. S. 220. Bland Co., July 26, sandy, organic mud at edge of Wolf Creek, Va. 61. Tazewell Co., July 26, same location given for *C. crepuscularis*. Buchanan Co., July 26, wet, thick mud at stream edge, 13 miles east of Vansant, U. S. 460. Buchanan Co., July 26, same location given for *C. crepuscularis*. Dickenson Co., July 26, black, organic mud at stream edge, 2 miles east of Haysi, Va. 83. Dickenson Co., July 26, sandy mud at edge of George's Fork Creek, George's Fork. Wise Co., July 26, wet mud at edge of Roaring Fork Creek, 3 miles west of Norton, U. S. 23. Lee Co., July 26, weedy mud at stream edge, 1 mile inside Wise county line, U. S. 23. Scott Co., July 26, weedy mud at stream edge, Clinchport, U. S. 23. Scott Co., July 26, sandy mud at stream edge, 14 miles west of Bristol, U. S. 23.

Previous Records: Accomack (13), Alexandria city (2), Augusta (2, 9, 10), Craig (11), Fairfax (2, 10), Franklin (12), Montgomery (8, 12), and Rockbridge (11, 12) counties.

Discussion: This is the first report of this species from the Cumberland and Piedmont plateaus. Previous records were essentially the same as with *C. crepuscularis*. *C. haematopodus* is now known to occur in Virginia from the Kentucky border to the eastern shore, and from the Potomac to the North Carolina border.

C. stellifer (Coquillett)

New Records from this Study: Albemarle Co., July 18, same location as given for *C. haematopodus*. Patrick Co., July 18, sandy wet mud with decaying rhododendron leaves, edge of small branch flowing into Rock Castle Creek, 17 miles northwest of Stuart, Va. 8.

Previous Records. Augusta (9, 10, 14) Chesapeake city (15), Craig (11), Fairfax (2, 10, 16), Franklin (12), Giles (8), Montgomery (12), Page (17), Rockbridge (12), Smyth (8), and Wythe (12) counties.

Discussion: Only two breeding sites of this species were encountered during the present study. It ap-

parently is not as common in this type breeding site as are the other three species discussed in this paper. It nonetheless has been recorded from southwestern Virginia to Chesapeake (Dismal Swamp) to Fairfax in the north.

C. venustus Hoffman

New Records from this Study: Tazewell Co., July 26, same location as given for *C. crepuscularis*. Lee Co., July 26, same location as given for *C. haematopodus*. Scott Co., July 26, same location as given for *C. haematopodus* at Clinchport. Scott Co., July 26, sandy mud at stream edge, 1 mile north of Duffield, U. S. 23. Grayson Co., July 27, weedy, leafy mud with reddish color in roadside seepage near Cabin Creek, 15 miles west of Independence, U. S. 58.

Previous Records: Augusta (2, 9), Fairfax (2), Franklin (12), Montgomery (8, 12), Roanoke (12), Rockbridge (12), Rockingham (12), and Wythe (12) counties.

Discussion: The present study shows *C. venustus* to occur in the Cumberland plateau region of the state. It previously was known only from the Blue Ridge-Shenandoah Valley area in western Virginia, and from Fairfax County in the north.

Conclusions

The significance of this study lies not in the fact that these records are new for the respective counties, for the latter are arbitrary political units and do not constitute distinct geological or ecological areas. Rather, the worth of most of these new records is in their originality for a particular geographical area of the state. *C. crepuscularis* and *C. haematopodus* are reported for the first time from the Cumberland and Piedmont plateau regions of the state, a significant diversion from the previous records which listed these species primarily from the Blue Ridge-Shenandoah Valley region, a distinctly different environment. *C. stellifer* is also reported for the first time from the Piedmont. These three species had previously been reported from Ferrum (Franklin Co.), at the edge of the Piedmont; however, this area is not typical of the Piedmont due to its higher elevation (1000 feet plus) and immediate proximity to the Blue Ridge. The new records of *C. venustus* show for the first time that it also occurs in the Cumberland plateau area. Additional collecting will undoubtedly show new ecological and geographical distributions of these and other species.

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Changes in Composition of Serum Lipoproteins in Rats and Male Rabbits Fed Various Diets*

Abstract—Serum lipoproteins of rats and rabbits fed various diets to elevate serum cholesterol content were fractionated into dextran sulfate precipitable and dextran sulfate non-precipitable fractions. The dextran sulfate precipitable material is considered to be low-density lipoproteins (LDLP). This fraction was analyzed for cholesterol, triglycerides and protein. A positive correlation was found between the LDLP cholesterol and protein concentrations in both rats and rabbits as long as the LDLP cholesterol was only moderately elevated. When serum LDLP cholesterol was rapidly increased by feeding a diet containing cholesterol and cholic acid to rats or a cholesterol-containing diet to male rabbits, the increase in LDLP protein lagged behind that of cholesterol and elevated ratios of cholesterol to protein developed. Correlation between LDLP triglycerides and protein was considerably less than for cholesterol and protein. The results are interpreted as supporting the concept that variations in the composition of the LDLP fraction may be an important factor in atherogenesis.

Although it is generally conceded that serum lipids play an important role in atherogenesis, no clear-cut relationship has been established between the concentration of any particular serum lipid fraction and the presence or absence of atherosclerosis (1, 2). Primarily, the low-density lipoproteins are considered to be involved (3, 4). The chief aim of the present investigation was to explore changes in the composition of the low-density lipoproteins when rats and rabbits were fed diets known to increase serum lipids. The diet in the case of the rats contained both cholesterol and cholic acid, and in the case of the rabbits, cholesterol with and without cortisol.

Kritchevsky, *et al.* (5) found good agreement between the cholesterol content of the low-density lipoproteins of human serum as separated by ultracentrifugation or by dextran sulfate precipitation. Sakagami and Zilversmit (6) showed that under appropriate conditions the dextran sulfate procedure precipitated the lipoproteins of densities less than 1.063 from hypercholesterolemic dog serum. Dilu-

tion was necessary when the serum was hyperlipemic. Although it is quite possible that some other serum protein or proteins may be precipitated along with the low-density lipoproteins by the dextran sulfate-calcium chloride procedure, we nevertheless felt that a study of the ratio of the protein moiety of the precipitate to its cholesterol and triglyceride content might be of interest, especially when the animals were on a diet known to affect serum lipids. Bearing in mind the above limitations, we will refer to the dextran sulfate-precipitable material as low-density lipoproteins (LDLP).

Although antithyroid substances are usually employed in addition to cholesterol and cholic acid for producing atherosclerosis in rats, Renaud and Allard (7) showed that the addition of an antithyroid substance was not necessary. Since in our study it seemed advisable to maintain the animals in a reasonable state of nutrition during the experimental period, we have not made as drastic a change in the animals' diet as has been employed in the actual production of atherosclerosis. All animals showed moderate growth and appeared to be in good health throughout the experimental period. Both a 10% and a 20% casein diet were included in the cholesterol-cholic acid experiments with male rats. Since the results were quite comparable, they have been combined in Table I. Substitution of glucose monohydrate (Cerelose) for sucrose also did not appear to affect the results. Coconut oil was used as a source of fat as it was thought that, being highly saturated, it might lead to more drastic changes than would be given by a highly unsaturated fat. Changes in the fat or protein content of the diet were compensated by comparable changes in weight of carbohydrate.

Composition of the cholesterol-cholic acid diet (diet 1), except as otherwise noted, was as follows: (All are expressed as grams per kilogram of diet.) Casein 200, sucrose or Cerelose 629, coconut oil 100, salt mixture (Wesson) 27, celluloflour 20, choline chloride 3, cholesterol 15, cholic acid 5, and 1 gram of a vitamin mixture containing B-complex

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vitamins. Vitamins A, D, and E were added to each animal's diet twice a week. Diet 2 contained 1.5% cholesterol, and 20% coconut oil. Diet 3 contained 20% coconut oil, but no cholesterol, while diet 4 contained 1.5% cholesterol but no coconut oil. Animals maintained on Purina Laboratory Chow served as normal controls.

Purina Rabbit Chow was used in all rabbit experiments. The other ingredients, cholesterol and cortisol, were dissolved in reagent grade chloroform, added to the diet, mixed thoroughly immediately, and the chloroform allowed to evaporate.

Male albino rats weighing about 190 gm, or re-tired females, were obtained from Holtzman Company. The animals were put on experimental diets and sacrificed by decapitation, at intervals thereafter. Blood was collected and allowed to clot. To obtain sufficient serum for the various analyses, blood from 2 to 4 animals had to be combined. When marked hyperlipemia was present, smaller volumes of serum were used. The LDLP were precipitated directly from the serum of all rats, and from the serum of rabbits on Purina Rabbit Chow alone. Since the sera of the other rabbits were consistently hyperlipemic, the chylomicrons were removed by centrifuging at 20,000 $\times g$ in a refrigerated centrifuge for 2 hours and the infranatant portion used for LDLP determination. The amount of serum or infranatant used for LDLP precipitation varied from 0.2 ml in the case of severely hyperlipemic rabbit serum to 3 ml in the case of rats with relatively normal serum lipid concentrations. In the case of the former, the infranatant fraction was diluted to 2 or 3 ml with 0.9% NaCl before precipitation of the LDLP. Heavy-walled glass-stoppered conical centrifuge tubes were used. The LDLP were precipitated by adding 0.04 ml of a 5% dextran sulfate¹ solution followed by 0.1 ml of an 11.1% calcium chloride solution and mixing. The tubes were set aside in a refrigerator overnight. After about 30 minutes centrifugation, the supernatant fluid was decanted and the tube carefully inverted on filter paper to drain. Cholesterol and triglycerides were determined on the precipitate using a procedure described previously (8). The precipitate in the tube to be used for protein determination was dissolved in 2 ml of 0.9% NaCl, with careful washing down of the sides of the tube. The lipoproteins were then reprecipitated as before. Solution and reprecipitation was repeated once more to make sure that all non-precipitable proteins had been removed. The protein content of the final precipitate was determined using the procedure of Thrift and Forbes (9). The biuret reagent of Gornall, *et al.* (10) which was used in this procedure was not suitable for the severe hyperlipemic conditions resulting from cholesterol feeding to rabbits, since the large amount of dextran sulfate in the precipitate interfered by reducing the reagent blank. This introduced no significant error in serum with normal or moderately elevated serum lipids, such as occurred in rats under all our experimental conditions. Folin and

Ciocalteu's phenol reagent (11) was used for results reported on rabbits. The dextran sulfate precipitate was dissolved in 10 ml of 2% Na₂CO₃ in 0.1 N NaOH. After about 10 minutes, 1 ml of diluted Folin and Ciocalteu reagent was added. The solution was mixed thoroughly and allowed to stand for 2 hours for maximum color development. The solution was then shaken with diethyl ether to remove opalescent material. The standard was treated similarly. A freshly prepared solution of crystalline human serum albumin was used as a standard in all cases, although a standard solution of tyrosine was found to be equally satisfactory.

Results

In order to show more clearly the apparent relationship between the LDLP cholesterol and protein in rats with only slightly elevated cholesterol, the individual cholesterol results obtained in rats on diets 3 and 4 were plotted against the corresponding protein values in Fig. 1. The corresponding triglyceride values were plotted in Fig. 2. Regression coefficients are shown by the solid lines. The cholesterol/protein values show a correlation coefficient of 0.68, but if the female controls are omitted it becomes 0.73. The correlation coefficient for the corresponding triglyceride values is 0.67.

Since it was evident that no correlation existed between LDLP cholesterol and protein in the animals with hypercholesterolemia, the results on the cholesterol-cholic acid fed animals are presented in tabular form (Table I). It will be noted that an increase in LDLP cholesterol was associated with an increase in the protein moiety. The increase in pro-

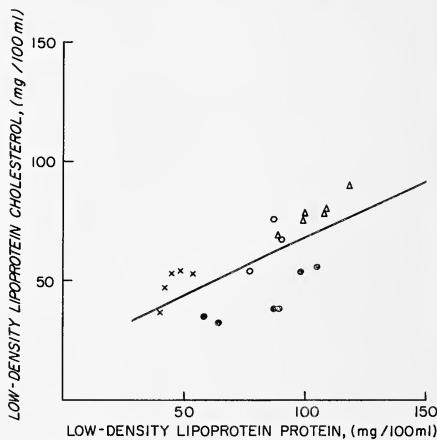


Fig. 1—Relationship between low-density lipoprotein cholesterol and protein in rats on several different diets.

- — Male rats on Purina Laboratory Chow
- X — Female rats on Purina Laboratory Chow
- △ — Male rats on diet 3 (20% coconut oil)
- — Male rats on diet 4 (1.5% cholesterol, no fat)

¹ Obtained from Société de Produits Chimiques de Boulogne-Sur-Seine, France.

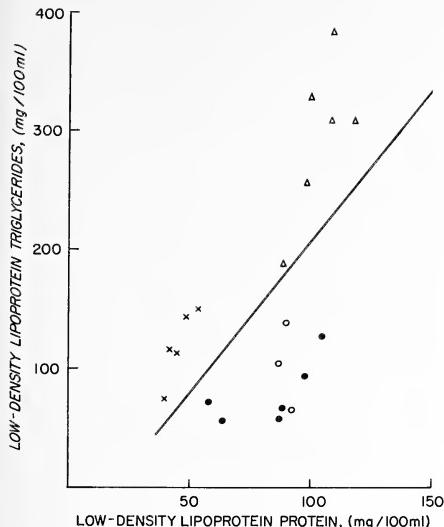


Fig. 2—Relationship between low-density lipoprotein triglycerides and protein in rats on several different diets.

● — Male rats on Purina Laboratory Chow
 X — Female rats on Purina Laboratory Chow
 △ — Male rats on diet 3 (20% coconut oil)
 ○ — Male rats on diet 4 (1.5% cholesterol, no fat)

tein, however, was much slower than the increase in cholesterol, and elevated LDLP cholesterol to protein ratios developed. Liver cholesterol was markedly increased in all of the rats fed cholesterol. It was about 8 times normal in those fed the cholesterol-coconut oil diet, and about 20 times normal in those

fed cholesterol and cholic acid. Liver triglycerides rose only to about 2 to 3 times normal.

The results with rabbits are shown in Table II. The difference between the serum and infranatant fraction shows the chylomicron concentration. It will be noted that a high concentration of chylomicron cholesterol can exist even though the serum triglyceride concentration is relatively low (rabbit 4).

Discussion

The results indicate that a slow increase in LDLP cholesterol tends to be associated with a corresponding increase in the protein moiety. Studies on human sera gave additional support for this hypothesis. Low-density lipoprotein cholesterol and protein were determined on 128 human sera whose LDLP cholesterol concentration varied from 100-400 mg/100 ml. A correlation coefficient of 0.88 was obtained. When the rate of cholesterol increase is rapid, as when cholesterol plus cholic acid is fed to rats, or cholesterol to rabbits, the rate of LDLP protein formation cannot keep up with the rate of cholesterol increase and elevated ratios for LDLP cholesterol to protein result. Although our studies showed a marked tendency for LDLP triglyceride concentration to rise along with cholesterol, this was not always the case. For example, rabbit number 4 showed a very high LDLP cholesterol while the triglyceride concentration remained within normal limits. Similarly elevated LDLP cholesterol concentration in the absence of a markedly elevated serum triglyceride concentration has been reported previously (12).

The fact that the ratio of protein to cholesterol and triglyceride of the LDLP can be influenced so markedly by dietary composition is of considerable interest. The two atherogenic conditions studied, namely the feeding of cholesterol-cholic acid to rats and cholesterol to rabbits, caused a marked increase in the cholesterol to protein ratio of the LDLP. It

TABLE I
Changes in Composition of Serum Low-density Lipoproteins and Associated Lipids in Rats Fed Diets Known to Lead to Hypercholesterolemia

Number of Experimental Groups	Sex	Serum			Low-density lipoproteins			Diet
		Chol.	TG	Chol.	TG	Protein		
6	M	mg/100 ml 60 ± 10*	mg/100 ml 104 ± 17*	mg/100 ml 43 ± 4.3*	mg/100 ml 79 ± 11*	mg/100 ml 83 ± 7.0*	Purina laboratory chow.	
3	M	158 ± 17	151 ± 35	126 ± 11	141 ± 30	97 ± 6.0	Diet 2: contained chol. and C.O.	
6	M	299 ± 17	180 ± 31	214 ± 21	141 ± 36	115 ± 4.8	Diet 1: contained chol. and cholic acid. Fed for 14 and 18 days.	
8	M	829 ± 57	218 ± 13	758 ± 58	192 ± 13	189 ± 5.4	Same as above for 21 and 28 days.	
5	F	103 ± 5.3	188 ± 19	49 ± 3.2	119 ± 17	46 ± 2.5	Purina laboratory chow.	
8	F	392 ± 39	273 ± 16	355 ± 38	178 ± 15	93 ± 6.0	Diet 1 for 13 and 18 days.	
6	F	377 ± 59	291 ± 26	305 ± 51	178 ± 11	97 ± 5.0	Same as above for 38 days.	

* Mean and standard error.

Chol. Cholesterol.

TG Triglycerides.

C.O. Coconut oil.

TABLE II
Serum Lipids in Rabbits Fed Cholesterol with and without Cortisol in their Diet

Rabbit Number	Serum		Infranatant fraction		Low-density lipoproteins			Days on Diet	Diet
	Chol.	TG	Chol.	TG	Chol.	TG	Protein		
	mg/100 ml	mg/100 ml	mg/100 ml	mg/100 ml	mg/100 ml	mg/100 ml	mg/100 ml		
1	98 ± 27*	162 ± 37*	—	—	75 ± 11*	115 ± 14*	85 ± 8*	—	Purina rabbit chow
	2175	459	1381	227	1304	219	292	7	Same plus 15 gm chol.
	6663	1647	4024	955	3550	893	838	15	+ 50 gm C.O. and
	10309	677	7225	503	6930	489	1021	31	20 mg cortisol per kg
2	10078	1318	6673	879	6298	775	880	65	of diet
	1431	222	1030	116	963	115	238	7	Same as above.
	4073	805	2746	506	2317	400	625	15	
	5414	1276	3580	764	3576	681	697	31	
3	5798	5335	2802	2822	2740	2292	659	65	
	1245	1035	897	638	870	571	265	7	Purina rabbit chow
	2799	1451	1703	683	1652	672	554	15	+ 15 gm chol. and
	6467	1035	4055	667	3844	553	697	31	50 gm C.O. per
4	6304	3236	3638	1481	3365	1472	666	65	kg of diet
	2192	160	1348	106	1304	79	292	7	Same as No. 3.
	3989	346	2469	196	2392	195	544	15	
	5716	160	3990	77	3702	36	665	31	
	4804	272	3852	141	3846	150	618	65	

* Mean and standard error of 8 determinations on control animals.

Chol. Cholesterol.

TG Triglycerides.

C.O. Coconut oil.

seems reasonable to assume that an increase in this ratio might be associated with a decrease in stability of the lipoprotein particles. We have shown in previous studies that when lyophilized serum from young male subjects 17-25 years of age was extracted with cold chloroform, only 9% of 441 sera showed cholesterol extraction in excess of 30 mg/100 ml. On the other hand in over 50% of subjects with myocardial infarction or arteriosclerotic heart disease this fraction was above 30 mg/100 ml (13). The extractable cholesterol was very high in the serum of nephrotic patients and hypercholesterolemic rabbits, comprising in some cases apparently all, or nearly all, of the serum cholesterol (14).

When all these results are considered, it would appear that the lipid composition of the LDLP may affect not only the extractability of its cholesterol moiety by cold chloroform, but also its atherogenicity. That nephrotic patients and cholesterol-fed rabbits are prone to develop atherosclerosis is, of course, well known.

Summary

The low-density lipoproteins of rats made hypercholesterolemic by feeding cholesterol plus cholic acid and rabbits fed cholesterol was analyzed for cholesterol, triglycerides, and protein. When its cholesterol concentration increased slowly, the protein moiety tended to be increased correspondingly. However, when serum cholesterol increased rapidly, as in cholesterol-fed rabbits, the rate of protein formation lagged far behind the cholesterol, giving markedly elevated cholesterol to protein ratios. It is sug-

gested that variations in the composition of the low-density lipoproteins may be a factor in atherosclerosis.

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Levels of the Herbicide Diquat[†] in Two Estuarine Molluscs and in the Water and Mud*

Abstract—Soft clams *Mya arenaria* and oysters *Crassostrea virginica* were exposed to 0.35 ppm of the herbicide Diquat during June and July 1967 in Nomini Creek, Virginia, a tributary of the Potomac. No detectable residue was found in oyster meats or in the water. Meats of soft clams, minus the rough integument surrounding the neck, showed no Diquat. The integument, however, contained from 0.00 to 0.05 ppm. Mud samples contained from 1.17 to 7.14 ppm. It was assumed that Diquat was strongly sorbed on clay particles in sediments; residues in clam integuments were due to trapped clay particles.

Introduction

During the past 20 years, herbicides have been used in increasing quantities to control vegetation in fresh-water ponds and lakes. More recently, they are being used for the same purpose in protected coastal marine areas where tidal currents, salinity changes and turbidity may dilute or modify the introduced chemical. Utilization in marine areas is complicated by the presence of edible fish or shellfish which may accumulate the herbicide beyond limits established by state and federal agencies. The possibility of accumulation and effects on growth or mortality has recently received much attention (1-3).

A recently introduced herbicide for terrestrial and aquatic use is Diquat (1,1'-ethylene-2,2'-bipyridylum dibromide), a quaternary ammonium compound. This compound satisfactorily controls aquatic weeds where suspended solids are low (4). Diquat, like other bipyridylum herbicides, is quickly sorbed from solution by clay minerals in soils. Consequently, shortly after introduction to an aqueous environment, it is found strongly sorbed on the surface of suspended clay particles or between lattices (5). The cation sorbed on the surface of the clay particles by ion exchange may become slowly available while that portion sorbed in the interlayer spacing of clays, such as montmorillonite, is more strongly bound (6).

The use of Diquat in marine areas where shellfish are grown made it desirable to evaluate its accumulation in animal tissue and in bottom deposits. Consequently, a field test was designed in which oysters

(*Crassostrea virginica*) and soft clams (*Mya arenaria*) were exposed to Diquat.

Area of Test

The tests were conducted at Nomini Creek, a tributary of the Potomac River.¹ Two stations, approximately one mile apart in the upper portion of the creek, were selected on the basis of a past history of dense growth of Water Milfoil (*Myriophyllum spicatum*). This rooted aquatic plant forms a dense growth in many shallow, protected bays in low-salinity regions of Chesapeake Bay. Water depth at each station was about 4 feet mean low water. At station number 1 the substrate was 38.7% silts and clay, with 11.3% sand; organic matter was 13.8% on a dry weight basis. At station number 2, 78.7% of sediment was in the silt-clay size range, with 21.3% sand; organic matter was 12.7%. Tidal currents in the two areas reached a maximum velocity of about 0.5 knot; salinity varied from about 4.0 to 10.0 parts per thousand (ppt) during the tests.

Methods

Preparation of stations—At each test area a one-acre plot was outlined with four stakes. Forty bushels of oyster shells were planted in a 10 ft² area in the center of each plot to provide a firm substrate for trays and boxes used in the tests.

During April, oysters, 3 to 4 inches long, obtained from the Potomac River, were placed in four wire trays measuring 45" × 25" × 8" with approximately 100 oysters in each tray. Soft clams, 2 or 3 inches long, were obtained from the Potomac and placed in five sediment-filled boxes measuring 18" × 18" × 8" with 18 to 20 clams in each box. Boxes and trays were stored at a dock in shallow water 1,000 feet from station 1. On 25 June, two oyster trays were placed on the shell bottom at station 1 and one was placed at station 2. A single tray was left at the dock. Four boxes containing soft clams were placed in the center of plot 1; one box remained at the dock. Water milfoil covered about 80% of plot 2; coverage on plot 1 was diffuse, but scattered concentrations existed over the entire area.

* Contribution No. 308 from the Virginia Institute of Marine Science.

[†]Registered trademark; provided by Chevron Chemical Co.

¹ Supported in part by a grant from the Chevron Chemical Co.

Analysis for Diquat was made by the Chevron Chemical Company, Richmond, California. The samples were refluxed in 18 N sulfuric acid to free the Diquat from the sorbed or bound state. After filtration, the extracts were diluted to 1 N strength, then passed through a cation exchange resin which adsorbs Diquat but passes the sulfuric acid and the dissolved constituents of the soil. The Diquat was then eluted with saturated ammonium chloride solution and determined colorimetrically by the sodium dithionite reduction reaction (7). Limit of detection for water and mud is 0.01 ppm and for clams and oysters, 0.02 ppm.

Sampling—Sampling began on 27 June 1967 with the collection of the pre-treatment sample from animals stored at the dock. A single sample consisted of meats from 15 oysters and meats from the entire contents of the soft clam box. Water samples were collected in 1-liter plastic bottles.

Prior to and during the removal of meats from oysters, care was taken to prevent mud adhering to the shells from coming in contact with meats. Shells were scrubbed under flowing water, knives were frequently washed, and, after removal, meats were dipped into freshwater to remove bits of adhering shell or mud. Meats were sealed in plastic bags and iced immediately after opening. Similar techniques were used in obtaining soft clam meats. However, the rough integument surrounding the siphon and extending along the open side of the animal was removed and sealed in a separate bag. After collection, all meats were frozen and shipped to the Chevron Chemical Company for analysis.

On 28 June at 11:00 a.m. after the initial sampling, plot 1 was treated with Diquat at the rate of 2 gallons per acre (0.35 ppm) by representatives of the Chevron Chemical Company and by personnel of the Virginia Institute of Marine Science. Plot 2 received a similar quantity of Diquat on 29 June at 1:00 a.m. Water temperature at station number 2 during treatment was 73°F, salinity was 7.7 ppt, and suspended solids was 36 mg/liter. Temperature,

salinity and turbidity at station number 1 were not measured.

Subsequent samples of animals and water for Diquat analysis were taken from both plots at intervals of 9 and 20 hours and at 3, 9, 18 and 36 days in the manner previously outlined. The 2-cm thick samples of substrate were taken at 9, 18 and 36 days. An additional series of ten mud samples was taken on 18 July 1968.

Results

There was no detectable residue of Diquat in water samples, oyster tissue or soft clam meats at any time during the study (Table I). However, low levels of Diquat were present in the integument from around the siphons of clams. Bottom muds contained from 1.17 to 7.14 ppm Diquat, with a mean of 3.96 ppm during the initial 36 days. Approximately one year after treatment, on 18 July 1968, levels in the mud were lower, with means of 4.07 and 1.19 ppm on plots 1 and 2, respectively.

By 4 August 1967, 36 days after treatment, about 70% of the milfoil had been killed on plot 2; on plot 1 the degree of kill was about 40%. During the test, no significant mortality of oysters or soft clams was noted in trays or boxes. The presence of a crystalline style in the digestive diverticula of all animals when opened indicated that both species had been feeding up to the time of collection.

Discussion

Published studies on persistence of Diquat in the marine environment and its effect on animals are lacking. However, limited data are available for freshwater lakes. Four lakes in Wisconsin were treated by Cope (2) with from 1.0 to 3.0 ppm Diquat. Detectable residues persisted from 10 to 48 days, depending on the original concentration and area. After 84 days, residues were not detected. Survival of adult and immature blue gills was not affected but adults had slightly less weight gain than controls. In a series of laboratory studies involving

TABLE I
*Time of Sampling and Diquat Residue Expressed as ppm in Clams, Oysters, Water and Mud,
Nomini Creek, Virginia, June-July 1967*

Station no.	Time after application								
	9 hrs	20 hrs	3 days	9 days	18 days	36 days	356 days		
Water	1	ND	ND*	ND					
	2		ND	ND					
Oyster	1	ND	ND	ND	ND	ND	ND		
	2		ND	ND	ND	ND	ND		
Clam	1	ND**	ND	ND	ND	ND	ND		
Clam integument	1		ND**	0.05	0.03	0.02			
Bottom mud	1			3.70	5.20	7.14	4.07***		
	2			1.21	1.17	5.36	1.19***		
Limits of Detection									
Water 0.01 ppm; oyster and clam 0.02 ppm									

* None detected.

** Integument not removed from around neck.

*** Mean of five samples.

salt water, 1.0 ppm of Diquat did not influence oyster shell growth after 96 hours (1). Similar studies with shrimp and fish showed no detectable influence on growth or mortality.

The most significant aspect of the present study was the consistent absence of detectable residues of Diquat in oysters and its absence in the edible portion of soft clams. The absence of Diquat residues in water was probably associated with its adsorption by silts or clays in suspension or by bottom muds and with the diluting effects of tidal currents.

The persistence of Diquat in bottom muds is comparable to its presence in soils in terrestrial locations, as outlined by Weber (6). Presence of detectable

residues in the rough integument of soft clam siphons was probably associated with soil particles trapped in the folds of the tissue.

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An Experiment in the Effective Use of Human and Physical Resources

Quality education requires community involvement and commitment. In the Richmond area, as well as in other areas of the state and nation, there is a wealth of human and physical resources waiting and ready to become involved in the process of education. The people and organizations of the community want to contribute skills, knowledge, understanding, and facilities to quality education for all children. In order to make effective use of these resources, key points need to be taken into consideration:

1. An organization has to be established which will be responsible for coordinating and providing direction to all activities involved.
2. An imaginative program with sound objectives has to be planned, initiated, modified, and pursued.
3. Short- and long-term financial support has to be available.

The Mathematics and Science Center is sponsored by the Richmond Public Schools in cooperation with the counties of Chesterfield, Goochland, Hanover, Henrico, and Powhatan and is funded locally and by the United States Office of Education, Title III, Elementary and Secondary Education Act. The idea to establish a Mathematics and Science Center was born in the minds of Richmond Public Schools Superintendent H. I. Willett, his staff, and other educators and interested specialists in the Richmond community. Although the Center is still in an early stage of development (two years), the initial successes of the program bear out the need, value, and worth of the idea to the Richmond area.

Through the Center, the human and physical resources of the Richmond region and Virginia ARE being used. The physical resources of the schools, school systems, businesses, industries, governments, and our good earth are being utilized effectively and on a large scale. For example, classes have visited local parks, hospitals, colleges, weather stations, mines, fish hatcheries, television and radio stations, pharmaceutical laboratories, camps, farms, forests, fire departments, dairies, computer centers, museums,

research laboratories, bakeries, arboretums, newspaper facilities, waterworks, state parks, national forests, national parks, radiation laboratories, banks, marine science laboratories, rivers, zoos, dumps, and swamps. The human resources—teachers, students, vocational specialists, researchers, hobbyists, and parents—are used year-round to help children learn mathematics and science.

The Mathematics and Science Center focuses its efforts in four broad categories:

1. Enrichment
2. General Education
3. In-Service Training
4. Information Dissemination

Enrichment opportunities are available both during the regular school year and the summer. The enrichment programs offered during the regular school year include:

Science Honors Seminars
Mathematics Honors Seminars
Scientist of the Week Programs
Special Programs in Mathematics and Science
Saturday Morning Explorers Program
Model Lesson Programs

Lectures and discussions by local mathematicians and scientists, recognized for their academic and research achievements, bring the frontier of knowledge close to the students in the Scientist of the Week Program. Special programs bring mathematicians and scientists from Virginia and nearby states to Richmond to share their specialized experiences and knowledge with the people of the Richmond area. Local teachers, administrators, professors, chemists, photographers, meteorologists, amateur radio operators, engineers, anthropologists, psychologists, and others teach children in the Saturday Morning Explorers Program. Selected students from the city of Richmond and the surrounding counties get into lively dialogue with mathematicians and scientists after they present their research experiences and discoveries to the Mathematics and Science Honors Seminars. A master teacher develops

model lessons in astronomy, volcanoes, microscopic animals, and chromatography. The lessons are presented to elementary classes in the region. While students are learning science concepts, teachers are becoming familiar with content, materials, skills, and methods for presenting a science lesson.

Secondary enrichment programs involve grades seven through twelve. The talks and discussions include such topics as relativity, speleology, thyroid research, wildlife art, animal populations, astronomy, radiation, medical transplants, animal behavior, drug purification, glassblowing, cryogenics, and insect control. Mathematicians and scientists participating in the programs come from universities, colleges, and organizations—for example, the Medical College of Virginia, University of Richmond, College of William and Mary, Randolph-Macon College, University of Maryland, Transylvania College, Virginia Polytechnic Institute, Virginia Commonwealth University, University of Virginia, Drew University, Audubon Society, Texaco Experiment, Incorporated, E. I. DuPont de Nemours and Company, Incorporated, Reynolds Metals Company, IBM Corporation, A. H. Robins and Company, and the Yerkes Primate Laboratory.

Summertime is fun time. It is a period of real learning for students and teachers. In science, students spend most of their time in the laboratory or in the field. Mathematics students learn theory, but special attention is given to application of theory to everyday life.

Although there is a variety of courses, emphasis in each is upon the unity of mathematics and science. Each enrichment course is taught by a team composed of a master teacher from college, secondary, or elementary ranks and one or two participating teachers, who, in an in-service capacity, are learning and teaching in the on-going program.

Courses offered during the summer, 1968 were:

Selective Preview of Organic Chemistry
Calculus in the Physical World
Probability and Statistics: An Introduction Through Experiments
Oceanography
Freshwater Ecology
Field Zoology and Botany
Field Geology
The Biology of Development
Introduction to Computers and Computer Programming
Field Mathematics of Earth Science
Mathematical Logic and Uses of Mathematics in the Sciences
Electronics
Our Mathematical-Scientific World
Interrelationship of the Living World and the Physical Environment

The city, surrounding counties, state, and nearby states become the classroom. Students in their studies travel east to the Tidewater region, south to the North Carolina coast, west to the Allegheny Mountains, and north to Washington, D. C.

In general education, the Center offers the Dis-

tinguished Mathematician-Scientist Lecture Series. The basic idea is to bring nationally or internationally known mathematicians and scientists to lecture on their special fields of interest. The ideas presented are related to discoveries and advancements which may influence the lives of people now or in the future. Dr. George Wald, Nobel Laureate, and Dr. J. Allen Hynek, director of the Dearborn Observatory at Northwestern University, presented public lectures at the Richmond Mosque during the 1967-68 school year. During 1968-69, Dr. Philip Morrison, professor of physics at Massachusetts Institute of Technology, and Dr. David Kreh, professor of psychology, University of California, Berkeley, spoke to a diverse audience composed of children, laymen, scientists, mathematicians, and teachers throughout the region. The average attendance has been 2,000.

During the 1967-68 school year, approximately 400 teachers attended courses at the Mathematics and Science Center to develop their skills and knowledge and to gain experiences that could be put to use as they work with students. In the sciences, emphasis was upon "firsthand" experiences in the field or laboratory; in mathematics, the "why" and "applications" were studied in depth. The variety of courses gives some indication of the approach:

Mathematics for the Elementary School Teacher
Mathematics for the Junior High School Teacher
An Introduction to Computers
Laboratory Instruments and Special Equipment
Photography—Darkroom Techniques and Procedures
Field Aspects of Earth Science
Selective Topics in Descriptive Astronomy
Fortran IV Computer Programming
Fundamental Concepts in Calculus
Flora and Fauna of Virginia
Elementary Science
The Teaching of Mathematics to the Slow Learner
Interrelationship of the Living World and the Physical Environment

In June, 1968, the information office of the Mathematics and Science Center published a *Directory of Mathematical and Scientific Organizations* in the Richmond area. We are predicting extended use of this directory by students, teachers, administrators, hobbyists, industrialists, and businessmen for the following reasons:

1. In mathematics and science, teachers and students often need to make contact with specialists or hobbyists in the community who have depth of experience in a particular area of knowledge.
2. Teachers and students like to become involved in organized activity in pursuing particular interest patterns.
3. People who are highly interested in their work or hobby often want to share their knowledge and interest with others.
4. Seeing the structure and function of mathematical and scientific facilities by on the spot

- examination, as contrasted to vicarious experiences, helps to make classroom learning a part of the *real* world.
5. Common and shared efforts by people working to accomplish an objective bring about good human relations and make life rewarding, enjoyable, and meaningful.

In October, 1968, the Center published a *Mathematical and Scientific Field Trip Guide* for the Richmond area. Projected for the future are: a *Directory of Mathematicians and Scientists* and a booklet, *Opportunities in Mathematics and Science for Students*.

The information office welcomes information from industry, schools, businesses, clubs, professional organizations, and others interested in mathematics and science. The office hopes to attain the status that when a person has a question about matters and events related to mathematics and science, he immediately thinks of the "Mathematics and Science Center" as a source of help.

In summary, the functions of the Mathematics and Science Center are:

1. To help children and adults in their quest for knowledge in the area of science and mathematics
2. To serve as a communication channel in the areas of mathematics and science education for schools, industry, interest groups, professional organizations, local and state offices and

agencies, and students and teachers at all levels

3. To provide general education in mathematics and science for the citizens of the region
4. To provide unique opportunities for learning throughout the entire year
5. To operate on the principle that unity, based on common interests, can arise out of diversity
6. To emphasize that continuous education in mathematics and science for ALL—students, teachers, and other citizens—is vital in a changing world and in a scientific and technological society
7. To serve as the means whereby community resources, human and physical, can be utilized with optimum effectiveness
8. To provide programs which serve as a capstone in the educational experiences for talented and gifted students
9. To serve as a focal point and provide leadership for educational activities related to mathematics and science
10. To generate and promote activities and programs which build interest, as well as mathematical and scientific attitudes in children of all abilities

Through varied and diverse activities, the Mathematics and Science Center is contributing in a meaningful way to excellence in mathematics and science education in the Richmond area and is providing programs to advance creativity in education.

Especially for Science and Mathematics Teachers

Ideas
Questions
Opinions

Applications of the General Law of Edsel Murphy to the Teaching of Science

It is interesting to note that most individuals involved in the fields of science or science education are well aware of the first name of the giants of science—but surprisingly few know the whole name of the man who first pronounced a basic law that has application in all fields of science and in the teaching of science. Indeed, the law may be universally applicable. We owe much of our understanding of Edsel Murphy to the diligent scholarship of D. L. Klipstein (1). In the paper cited, Klipstein developed several corollaries of the general form of Murphy's Law as it applies to the electronics engineering field. It is the purpose of the present communication to perform a similar service for the field of science education.

There have been several variations of the original law as pronounced by Murphy, and in the interest of accuracy it is therefore quoted from the original source¹: *If anything can go wrong, it will.* The law can be expressed in mathematical form: $1 + 1 = \frac{?}{2}$, where the symbol $\frac{?}{2}$ represents hardly ever. In syllogistic form Murphy's Law may be expressed as: "If all A's are B's and all B's are C's, then all A's will probably turn out to be not C's".²

It would be an impossible task to compile all of the special applications of the general law as it pertains to science education. Therefore, the author has selected several of the most important corollaries from each of the main areas of concern to science teachers.

I. General Applications

- I.1 Any audio-visual supplements to the lesson will arrive one week early or one week late.
- I.2 When your lecture or demonstration or discussion has reached its ultimate point of empathy, the office will remind the students of the impending rally, via the room p.a. speaker.
- I.3 At least three of the answers to the problems, provided in the teacher's edition of the text, will be wrong.
- I.4 If the number of chairs in your classroom is n , you will be assigned $n + 1$ students.
- I.5 If you have been hired to teach 5 classes of Biology and one planning period, there will develop an additional class in Biology.
- I.6 The amount of preparation you have put into

¹ The original source disappeared during the preparation of the present paper. In accordance with Murphy's Law it should come to light the day after this journal goes to press.

² Klipstein, *op. cit.*, states that the law in its simplicity came to Murphy when his bride-to-be informed him he was to become a father.

a given lesson is inversely related to the likelihood that it will be observed by the principal and supervisors.

- I.7 The amount of time and effort you put into constructing a test is directly related to the likelihood that it will be compromised.

II. Teacher Demonstrations

- II.1 An essential piece of apparatus will be irreparably broken during the first period demonstration and there will be no duplicate piece available for use in the following periods.
- II.2 The unlabeled jar which you think contains sugar, contains salt.
- II.3 Your demonstration of handling glassware safely will result in a severe gash in your hand.
- II.4 A demonstration voltmeter which can be hooked up incorrectly, will be.
- II.5 At the crucial point of the demonstration the attention of the class will be diverted to a passing fire-engine or other disturbance.
- II.6 The description of your proposed demonstration will invoke several responses of either (a) we saw that last year in science, or (b) we saw that this year in p.e.
- II.7 If the demonstration requires n number of flasks, there will $n-1$ number of clean ones available.

III. Student Laboratory Activities

- III.1 (Biology) The sample of pond water you collected over the weekend to demonstrate "Life in a Drop of Water" will be sterile.
- III.2 The petri dishes and pipettes for the bacteria lab will not be sterile.
- III.3 The number of microscope lamp bulbs that will burn out in one lab period will exceed the number of available spare bulbs by a factor of two.
- III.4 (Chemistry) The number of two-hole stoppers of appropriate size for the flasks available will be equal to one-half the number of student lab set-ups.
4(a) The number of two-hole stoppers of the next largest size will be twice the number of student lab set-ups.
- III.5 The amount of manipulations to be performed by the students in a given lab will vary inversely as the amount of time available.
- III.6 The number of tubes of hydrogen gas tested with a burning splint will be 2.5 times the number required to establish the findings.
- III.7 (General Science) A meter protected by a fast-

acting fuse, will protect the fuse by burning out first.

III.8 When all else has failed, the students will read the directions.

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A Simple Titration Procedure

A plastic "squeeze bottle" fitted with a cap and molded tip can serve as an inexpensive weight buret. Since the weight of the bottle can easily be determined to the nearest 0.01 gram using a triple beam balance, while a buret is not easily read to closer than 0.02 ml, techniques using a plastic bottle and triple beam balance are at least as accurate as those using burets for titrations. In using a plastic bottle as a weight buret, two precautions should be kept in mind: (1) The cap must be screwed on very tightly to prevent leaks around the threads; and (2) in delivering the solution from the bottle, the bottle must be squeezed gently to reduce spattering of the solution in the titration flask.

Preparation and Standardization of NaOH Solution

A. Preparation of Approximately 0.2 N NaOH Solution

1. Using the triple beam balance, weigh 4.0 ± 0.2 grams of NaOH pellets in an evaporating dish or small beaker. (Avoid unnecessary exposure of pellets to air, as NaOH takes both water and carbon dioxide from the air.)

2. Transfer the pellets to a 500 ml polyethylene bottle; add distilled water until the bottle is filled to the shoulder. Cap the bottle firmly and shake it until the pellets have dissolved and the solution is thoroughly mixed. (Failure to dissolve the pellets and mix the solution is a major source of error.)

B. Standardization of NaOH Solution vs Potassium Hydrogen Phthalate

1. Weigh a 250 ml Erlenmeyer flask to the nearest 0.001 gram. (If weighings to 0.001 gram cannot be made, weigh to 0.01 gram.) Add 1.6 to 1.9 grams of potassium hydrogen phthalate (KHP) to the flask. Weigh the flask and crystals to the nearest 0.001 gram.

2. Add 90-110 ml of distilled water to the flask with KHP, swirl and warm, if necessary, to dissolve the crystals.

3. Fill a 2 oz (60 ml) polyethylene bottle to within 2 cm of the rim with 0.2 N NaOH solution. Screw the cap on firmly. Test for leaks around the cap by placing a finger over the tip of the delivery tube, inverting the bottle, and then squeezing it. If

solution leaks around the cap, tighten it, then test again. Make certain that the outside of the bottle is clean and dry before weighing.

4. Weigh the bottle with NaOH solution to the nearest 0.01 gram.

5. Add three drops of phenolphthalein indicator solution to the solution of KHP in the flask. Place the flask over a white surface and titrate the KHP using NaOH solution from the weighed bottle until the solution in the flask just retains a faint pink color after thorough mixing. Wash the sides of the flask with water from a wash bottle a few drops before the endpoint is reached. If more than one drop of NaOH solution is added beyond the endpoint, discard the determination.

6. Weigh the bottle with unused NaOH solution to the nearest 0.01 gram.

7. Calculate the normality of the NaOH solution.

8. Repeat steps 1-7 inclusive. If the two values differ by no more than 1%, take their average and use that value for the normality of the NaOH. If the two values differ by more than 1%, make a third determination.

Determination of Acetic Acid in Vinegar

1. Obtain a sample of vinegar and transfer this to a dry 1 or 2 oz polyethylene bottle. Screw the cap on firmly; test for leaks around the cap (see step 3, standardization of NaOH). Weigh the bottle and vinegar to the nearest 0.01 gram.

2. Fill a 2 oz (60 ml) polyethylene bottle with standard NaOH solution. Screw the cap on firmly; test for leaks around the cap. Weigh the bottle and solution to the nearest 0.01 gram.

3. To about 100 ml of distilled water in the 250 ml flask, add 3 drops of phenolphthalein indicator. Then squeeze about 7 or 8 grams of the vinegar into the flask.

4. Titrate the vinegar solution with standard NaOH solution to the first permanent pink. If the vinegar is overtitrated, i.e., a dark pink is obtained,

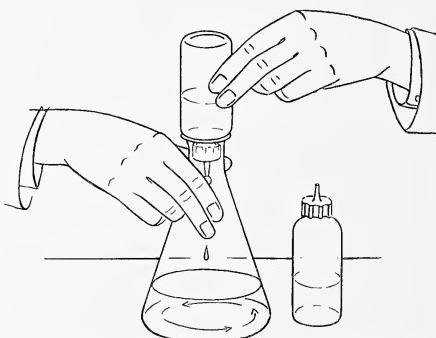


FIG. 1—Titration using 60 ml (2 oz) polyethylene dropping bottles and 250 ml conical flask. Shoulder of bottle rests on the neck of the flask.

add a drop or two of vinegar to discharge the pink, then add NaOH solution until the color just returns.

5. Weigh the vinegar bottle and then weigh the NaOH bottle, each to the nearest 0.01 gram.

6. Make a second determination, beginning at step 2 above, using another third of the vinegar sample.

7. Calculate the percentage of acetic acid in the vinegar. The values for % HOAc for the two determinations should agree to within 1% of each other. If these two determinations differ by more than 1%, i.e., by more than 5 in 500, make a third determination using most of the vinegar remaining in the bottle.

Sample Calculations

Assume that one gram of the dilute NaOH solution is exactly one milliliter of solution and calculate as when using a volumetric buret.

- (1) *Standardization.* A 1.845 g sample of KHP required 45.34 g of NaOH solution for titration to the phenolphthalein endpoint.

$$1.845 \text{ g KHP} \times \frac{1 \text{ milliequivalent}}{0.2042 \text{ g KHP}} =$$

$$9.035 \text{ meq KHP} = \text{meq NaOH}$$

$$\frac{9.035 \text{ meq NaOH}}{45.34 \text{ g NaOH soln.}} = 0.1993 \text{ meq/ml} = \\ 0.1993 \text{ N NaOH solution}$$

- (2) *Calculation of % acetic acid.* An 8.20 gram sample of vinegar required 35.45 g of 0.1993 N NaOH for neutralization.

$$35.34 \text{ ml} \times 0.1993 \text{ meq/ml} = 7.065 \text{ meq NaOH} = 7.065 \text{ meq HC}_2\text{H}_3\text{O}_2$$

$$7.065 \text{ meq} \times 0.06005 \text{ g HC}_2\text{H}_3\text{O}_2/\text{meq} = 0.4243 \text{ g HC}_2\text{H}_3\text{O}_2 \text{ in sample}$$

$\frac{0.4243 \text{ g HC}_2\text{H}_3\text{O}_2}{8.20 \text{ g sample}} \times 100 = 5.174 \%$ acetic acid in vinegar.

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TEACHERS! !

Do you have a question that you'd like answered?

Do you have a favorite demonstration, method of getting across a concept, or an experiment that you'd like to share with others?

Do you have a technical article that you'd like to have published?

Are you involved in a program, a course of study, or an activity which you think would be of interest to other educators?

Would you like to analyze or give a critical evaluation of a curriculum, talk, article, or book?

Would you like to do a little philosophizing?

GREAT NEWS—NOW IS YOUR CHANCE! !

The editor of the Virginia Journal of Science plans to devote a page or two in each issue to items written especially for junior and senior high school teachers of science and mathematics. We are now soliciting contributions which will be of interest to teachers and which will be of value in furthering scientific and mathematical education in the state.

Send your contributions to Virginia C. Ellett, Mathematics and Science Center, 4225 Old Brook Road, Richmond, Virginia 23227. Do this right away so that they may appear in the next issue of the Journal, but don't stop here. Let this be the beginning of many articles from you. Remember this is YOUR section and its success depends upon your contributions.

Communications and Reports

The Pocket Encyclopaedia of Plant Galls in Colour

By ARNOLD DARLINGTON with illustrations by
M. J. D. HIRONS

Philosophical Library, Inc.
New York, 1968.
191 pages, \$7.50

Books on the subject of plant galls are few and far between. Little wonder, then, that when one appears it is certain to stimulate a great deal of interest among naturalists and most biologists. This small volume should be no exception. Although the author, Senior Biologist at Malvern College and member of the Biology Section of the Nuffield Foundation's Science Teaching Project, writes about plant galls found in his native England, many of the color illustrations either will be familiar to observant Americans or will make them aware of similar intriguing structures on plants in their own back yards. With the help of the illustrations and descriptions in the book many of our common galls can be identified. For example, galls found on oaks can be compared against more than fifty colored plates of typical galls formed on these plants.

One approach available to a reviewer is to measure the work against the author's objectives. In this instance the stated aims are: a) to provide a means of identification of commonly occurring plant galls, b) to provide an insight into the mode of life of the various types of gall-causing agents, and c) to suggest simple investigation into the biology of galls. Obviously, in a pocket-sized book of 191 pages it is not possible for the author to treat each of these aspects with equal emphasis.

All but forty pages of the book are devoted to identification of galls or their causes. This section is organized in the style of many popular field guides useful in identifying unknown specimens by comparison with an illustration. Here, the type specimen is represented by a color photograph, greatly enhancing the book's usefulness. A supplement of descriptive and helpful comments for each plate follows the illustrations and completes this section. This reviewer feels that the author fulfills his objective.

About thirteen pages are devoted to the second aim. Adepts may not find anything new here but beginners will be introduced to a fascinating area of biological specialization. They will become acquainted with causes, parasites, predators, and hyperparasites and with their respective roles in the gall community. If, in the future, improvement were to be tried, this area could profit most from additional material.

In five pithy pages the author tells how a beginner may go about investigating galls and their causes on his own. He describes how and where to collect, how to preserve collected specimens, and, finally,

suggests ways of rearing and culturing living material for purposes of study. Classes in high-school biology, particularly, should find ideas for class or individual projects in this short, but stimulating, section of the book.

In summary, this is a remarkable little book. Those who will read it and who will study the illustrations are bound to gain a fuller appreciation of the living world around them.

WILLIAM STEPKA

The Preservation of Natural History Specimens Vol. II (Zoology-Vertebrates also Botany Geology)

By R. WAGSTAFFE and J. H. FIDLER

Philosophical Library, Inc.
New York, 1968
404 pages, \$17.50

This book presents a series of techniques employed in the past, or in current use, to aid science workers in processing or preserving their specimens. The editors also comment on those techniques with which they were most favorably impressed.

The book is good in that it presents a worker with a variety of techniques in the form of condensed procedural descriptions. Also listed with each technique is a bibliography from which the technique is gleaned.

The editors are either amazingly talented or the techniques are not always commented on realistically. A good example is found in the section on reptiles and amphibians. The authors describe a technique—Walters—for reproducing specimens for display that is next to impossible to master. Their comment is that the process is simple and much more satisfactory than any other. Many museums in this country have spent considerable sums training their technicians in this method only to be disappointed when their most talented preparators couldn't master the process. It is found that the final celluloid painting must be done in an atmosphere heavily laden with amyl acetate. This is an explosive condition and amyl acetate gives many workers asthma or nausea when exposed to prolonged breathing of the vapors. The fact that ventilation cannot be used because it causes blemishes in the cast prevents work under a hood. None of this is brought out in the discussion.

Under microscope techniques, Kroehler illumination, one of the most satisfactory illuminations for photomicrography is omitted.

Since the scope of the work is very broad, pitfalls of this type are easily understood. Therefore, the reviewer recommends a thorough investigation of a technique via the bibliography and letters to sister institutions before materials are purchased or work

is attempted. It is also advised, because of the British orientation in the book, that American science supply houses be contacted for equipment and information on allied techniques oriented to American materials.

JEAN DUVAL KANE

Introduction to Zoology

By T. H. SAVORY

Philosophical Library, Inc.
New York, 1968
239 pages, \$6.00

The title of this book is extremely misleading, as the author by his own admission neglects histology, embryology, physiology, genetics, behavior and parasitism and deals almost solely with systematics and evolution. After an extremely brief discussion of the nature of zoology as a science, he provides a nice introduction to the principles and practices involved in classification of the animal kingdom and the use of zoological nomenclature. He offers his own scheme of classification based on recent work in this area, but also provides more traditional divisions where the new groupings may be controversial. The remainder of the book deals with diagnostic descriptions of these groups of animals. This portion of the book may be quite comprehensible to a person with adequate training in biology, but I fail to see how it could be of much use to a beginner in need of an introduction to zoology. The author consistently uses terminology either without definition or with

definitions phrased so as to be almost meaningless to the non-zoologist, for example a blepharoplast is parenthetically defined as a basal granule or kinetosome.

In summary, I would not recommend this book to anyone interested in a true introduction to zoology. It may, however, be of use to those interested in a handy reference to the major characteristics of the many animal groups.

PETER JEZYK

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LYNN D. ABBOTT, JR.

News and Notes

SCIENTIST SELECTED

Dr. Warren W. Brandt, currently executive vice president of Virginia Polytechnic Institute, will become the first president of Virginia Commonwealth University in Richmond, June 1, 1969. Virginia Commonwealth University was created by the 1968 General Assembly and came into being on July 1, 1968 when the Richmond Professional Institute became the General Academic Division and the Medical College of Virginia became its Health Sciences Division.

Doctor Brandt is a native of Lansing, Michigan and received his B.S. degree in chemistry from Michigan State University in 1944. He received a Ph.D. degree in analytical chemistry from the University of Illinois in 1949. He served with the United States Army from 1944-1946 and was a Guggenheim Fellow at Oxford University in 1958.

Doctor Brandt came to Virginia in 1963 as dean of the graduate school at Virginia Polytechnic Institute. Later that year, he was named vice president for academic affairs. He assumed his present duties as executive vice president in 1968.

Doctor Brandt has been a member of the faculties of the University of Illinois and the University of Indiana, and has headed Departments of Chemistry at Purdue University and at Kansas State University. He has directed the research of 19 Ph.D. and 18 M.S. students and has published extensively in chemical journals and books dealing with analytical chemistry.

Doctor Brandt's memberships in scientific societies include the Virginia Academy of Science, the American Association for the Advancement of Science and the American Chemical Society, and he has served as chairman of the Division of Analytical Chemistry of the latter organization.

VIRGINIA INSTITUTE FOR SCIENTIFIC RESEARCH

Dr. J. Samuel Gillespie, Jr., was elected Director of the Virginia Institute for Scientific Research at the Institute's Board of Trustees meeting on January 21, 1969. Dr. Gillespie had been appointed acting director of VISR last February when Dr. Henry Leidheiser, who had been Director since 1960, was appointed professor of chemistry and Director of the Center for Surface and Coatings Research at Lehigh University.

Dr. Gillespie is a graduate of the Virginia Military Institute, and he received his Ph.D. in chemistry from the University of Virginia in 1949. From 1949 to 1951 he was assistant professor of chemistry at the University of Richmond, and then he joined the Virginia-Carolina Chemical Corporation. In 1958, he became a partner in the firm of Cox and Gillespie, and concurrently served as president of Commonwealth Laboratory, Inc. He joined VISR as a senior

research chemist in 1962, and was appointed head of the organic chemistry division there in 1966.

The Institute, a private, non-profit research organization, is the fruition of an idea conceived by the late Dr. Allan T. Gwathmey when he was a member of the Research Committee of the Virginia Academy of Science. Sponsorship of the Institute was undertaken by the Academy in 1946 to remedy the deficiency of the Commonwealth of Virginia in modern scientific research. In 1947 the Academy, through its Research Institute Committee purchased a microscope, retained Dr. John Strickland, now professor of biology at the University of Richmond, and began the Institute's first research project, a fundamental study of cell growth. Presently located in its modern laboratory building near the University of Richmond, the Institute conducts sponsored research in the chemical, physical, and biological sciences.

UNIVERSITY OF VIRGINIA HONORS

At an annual meeting of Sigma Xi on March 19, the 45th annual President's and Visitors' Research Prize, established to stimulate research in pure and applied science, was presented to Dr. Lester S. Andrews, assistant professor of chemistry, for his paper entitled "Chemical Intermediates in the Reaction of Carbon Tetrachloride with Alkali Metal Atoms."

Dr. Andrews received his bachelor's degree from Mississippi State University and was a teaching assistant while working for his doctorate at the University of California at Berkeley. He joined the University of Virginia in 1966.

The Allan Talbott Gwathmey Memorial Award for outstanding research ability in the physical sciences went to Dr. Andrew Barrett Turner, now studying and teaching on a post-doctoral fellowship at the University of Florida. Dr. Turner, whose major research centers around seven-membered ring systems, received his Ph.D. in chemistry from the University of Virginia in 1968.

The Andrew Flemming Award in Biology was awarded to fourth-year graduate student, Alan M. Kohen of Chicago. A Ph.D. degree candidate, Kohen was recognized for general research excellence. His major research interest is the embryonic differentiation of sympathetic nervous systems.

Honorable mention for the President's and Visitors' Prize went to Dr. Allen M. Lefer, assistant professor of physiology, Richard L. Verrier, fourth-year graduate student in physiology of Biddeford, Me., and Walter W. Carson, fourth-year medical student of Lexington. Their paper was titled "Cardiac Performance in Experimental Adrenal Insufficiency in Cats."

LIFE SCIENCES BUILDING DEDICATED

In conjunction with Charter Day exercises celebrating the 275th year of the College of William

and Mary in Williamsburg, Virginia, February 7 and 8, 1969, the new \$2.8 million John Millington Hall of Life Sciences was dedicated. The building houses biology and psychology departments and is named for a 19th century professor at the college. A symposium on "Psychobiology and Behavior" was held in the main auditorium of the new building on February 7. Dr. J. McV. Hunt, Professor of Psychology and Education Psychological Development Laboratory, Department of Psychology, University of Illinois, spoke on "Informational Interaction and Maturation." Dr. Stanley B. Williams, Chairman of the Psychology Department, moderated the discussion of this paper. Dr. Jose M. R. Delgado, Professor of Physiology (Psychiatry), Yale University School of Medicine presented "Transdermal Communication with the Brain." Discussion was led by Dr. Garnett R. Brooks, Associate Professor, Department of Biology. The afternoon program presented Dr. Neal E. Miller, Professor of Psychology, The Rockefeller University, speaking on "Chemical Coding of Behavior in the Brain." Discussion of this paper was led by Dr. Williams. The final paper on the afternoon program, presented by Dr. William L. Byrne, Professor and Chairman, Department of Biochemistry, College of Basic Medical Sciences, The University of Tennessee, was entitled "Molecular Basis of Long Term Memory—A Progress Report." Dr. Robert E. L. Black, Professor of Biology, led the discussion. Introduction to the day's program was provided by Dr. Mitchell A. Byrd, Chairman of the Department of Biology.

At the Charter Day exercises on February 8, the main address was presented by Dr. Robert Q. Marston, Director of the National Institutes of Health, and honorary degrees of Doctor of Science were awarded by the College of William and Mary to Dr. Marston and to Dr. William G. Guy, former head of the college Chemistry Department who retired last June. Dr. Marston is a native of James City County and is a graduate of Virginia Military Institute and the Medical College of Virginia where he also served on the faculty and was assistant dean of medicine. Dr. Guy, chancellor professor of chemistry emeritus, retired after teaching at the college 43 years. He is a graduate of the University of Chicago and is a former Rhodes scholar. Dr. Guy was president of the Virginia Academy of Science, 1957-58.

CHEMISTRY BUILDING DEDICATED

Chemists from throughout the United States, alumni of the University of Virginia, and the architects, contractors and engineers who helped design and build the University of Virginia's new chemistry building were on hand for its official opening and dedication ceremonies, March 14, 1969.

The 6.5 million dollar structure is the newest addition to a growing science and engineering group. It is the largest and most complex building on the campus, with five stories and 160,000 square feet. The new building represents a gain in teaching as well as research facilities. It has about four times the teaching space as the old Cobb Chemical Labora-

tory which it replaces and which was dedicated in 1920. It contains an auditorium seating 500, a lecture room seating nearly 100, and seminar, conference and classrooms, as well as extensive research and teaching laboratory facilities. The main stock rooms, shops, library, research laboratories and faculty offices are on the lower two floors. The main lobby is on the third floor, which, with the fourth floor, contains undergraduate laboratories, classrooms and administrative offices. The fifth floor contains air conditioning equipment and specially constructed laboratories (including an "explosion-proof" room), as well as facilities for maintenance personnel and storage. The chemistry building is the only building on the campus to use 100% fresh air with no recirculation. The average consumption is about 250,000 cubic feet per minute. On peak days, the building will use approximately 1300 tons of air-conditioning.

In addition to the building itself, much new equipment for teaching and research has been acquired, of which the major items include a computerized x-ray crystallographic laboratory, Varian and Hitachi Perkin-Elmer NMR spectrometers, and Hitachi and AEI mass spectrometers. Some of the recently purchased equipment was obtained through a Center of Excellence Grant recently awarded the University by the National Science Foundation.

Although the National Science Foundation, National Institutes of Health and other federal sources contributed considerably to the construction of the new building, almost 64% of the total cost came from state funds. The planned capacity, expected to be reached during the 1970's, includes approximately 30 full-time faculty members and 120 graduate students, plus a number of postdoctoral and technical assistants.

Tours through the building were conducted during the afternoon and a dedication ceremony was held at 5:00 p.m. The building was accepted by President Edgar F. Shannon, Jr., of the University of Virginia and turned over to Professor R. Bruce Martin, chairman of the department of chemistry. The major address was presented by Dr. Donald F. Hornig, professor of chemistry at the University of Rochester, vice president of the Eastman Kodak Company and special assistant for Science and Technology to former President Lyndon B. Johnson. Professor Hornig was selected by President Johnson in 1964, when he was Donner Professor of Chemistry at Princeton University. A former Guggenheim and Fulbright Fellow at Oxford University, Dr. Hornig was scientist and group leader for the Los Alamos atomic bomb project during World War II. During his 10 years as Science Advisor to President Johnson, Dr. Hornig contributed to the initiation of many international scientific and technological activities, prepared recommendations on various defense problems, on problems of housing and urban development, transportation, civilian technology, academic science and others. In his address entitled "Science and Soul" he discussed the scientific progress of man through the ages and presented thoughts on how

scientific knowledge might help alleviate social problems.

Later in the evening, the Virginia Section of the American Chemical Society met in the new Chemistry Building Auditorium to hear an address by Dr. Daniel Banes, Director of the Division of Pharmaceutical Science in the United States Food and Drug Administration. Dr. Banes discussed "Psychedelic Drugs—Ancient and Modern" in which he reviewed the chemistry, natural occurrence and use of the main types of chemical compounds involved.

SCIENCE CENTERS STARTED

Construction of a \$4 million Randolph-Macon College science building at Ashland was begun with ground-breaking ceremonies on March 29, 1969. The structure will house the biology, physics, chemistry, computer science, psychology and mathematics departments, and will connect with Smithley Hall. The building is due completion by fall of 1970. Members of the college community, architects, consultants and contractors participated in the ground-breaking ceremonies. More than 2,000 scientists and alumni were invited to attend.

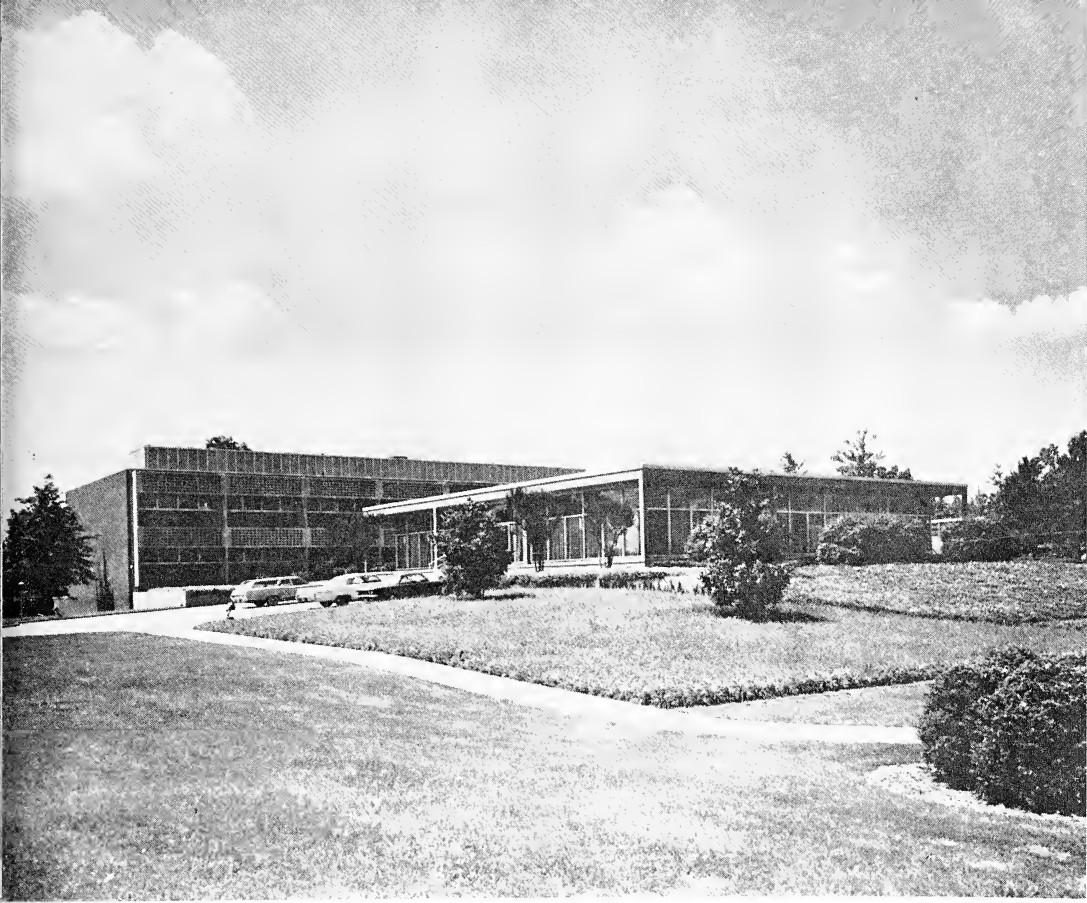
Construction is well underway for Roanoke College's new 3.5 million dollar science center. It will contain a Life Sciences Building, a Physical Sciences Building and a 225 seat Lecture Hall.

Mary Baldwin College's \$2 million Science Center, now under construction at the corner of Coalter and Frederick Streets in Staunton, is expected to be completed early next year. The chemistry department will occupy the top floor and will include a general laboratory; six smaller laboratories, three of which will be for research; three faculty offices; a seminar room; a departmental library, and instrument and balance rooms. It will be named for John Baker Daffin, professor emeritus, who was the college's one-man chemistry department for 35 years.

Professor Daffin, now a teacher of chemistry and director of development for Stuart Hall, a girls' preparatory school in Staunton, retired from college teaching in 1965. He remained on the college staff the next two years as special assistant to the president. Along with his duties as professor of chemistry he also served successively as college bursar, treasurer and comptroller.

Often honored as a magnetic and zealous teacher, Mr. Daffin led generations of students through active research which they often presented at regional and national chemical society meetings. He was instrumental in placing chemistry majors in important industrial positions, as well as in graduate schools.

The Science Center is the beneficiary of the current financial campaign of the Presbyterian Synod of Virginia which is seeking \$2 million for its two colleges, Hampden-Sydney and Mary Baldwin.



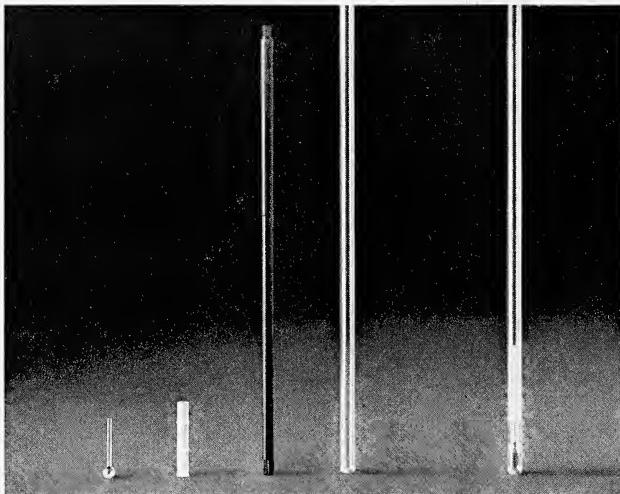
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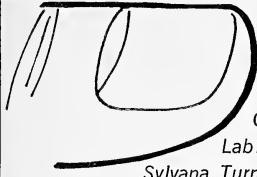
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*Applied Spectroscopy, May-June, 1967, Vol. 21 #2, "Microcell for Nuclear Magnetic Resonance Analysis," R. A. Flath, N. Henderson, R. E. Lundin, and R. Teranishi.

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All articles should be typewritten (double-spaced) and submitted on good bond paper ($8\frac{1}{2} \times 11$ inches) in triplicate to the Editor. Margins should not be less than $1\frac{1}{4}$ inches on any border. Title, running title, authors, place of origin, abstract, figures, legends, tables, footnotes, and references should be on individual pages separate from the text. Technical abbreviations should follow consistent standard practices with careful avoidance of unnecessary neologistic devices. All pages (including illustrations) should be consecutively numbered in the upper right corner. A pencil notation of author names on the back of each page is helpful in identification.

Illustrations should be supplied in a form suitable for the printer with attention to the fact that a reduction in size may be necessary.

A good technical article generally contains an obligatory abstract before the text, an introduction, with reference to preliminary publications that may exist, an experimental section, results (which may be included in the experimental section), a discus-

sion, and conclusion. References are indicated in the body of the article by consecutively used numbers in parentheses. Although publication costs are high, attention should be given to relatively complete references (bibliographies) since the purpose of an article is to illuminate the significance of present and past findings, and not merely to obscure the past. The Journal reserves the right (generally exercised) to make page charges for articles in excess of 5 pages and to bill authors at cost for unusually complicated illustrative material.

Abbreviation of journals for references can be found in the 4th edition of the *World List of Scientific Periodicals*, Butterworth, Inc., Washington, D. C., 1963, and supplements. References should be checked carefully.

The form of presentation is illustrated below:

1. Aiyar, A. S., and Olson, R. E., *Fedn Proc. Fedn Am. Socys exp. Biol.*, **23**, 425 (1964).
2. Chappell, J. B., Cohn, M., and Greville, G. D., in B. Chance (Editor), *Energy linked functions of mitochondria*, Academic Press, Inc., New York, 1963, p. 219.
3. Riley, G. A., and Haynes, R. C., Jr., *J. biol. Chem.*, **238**, 1563 (1963).

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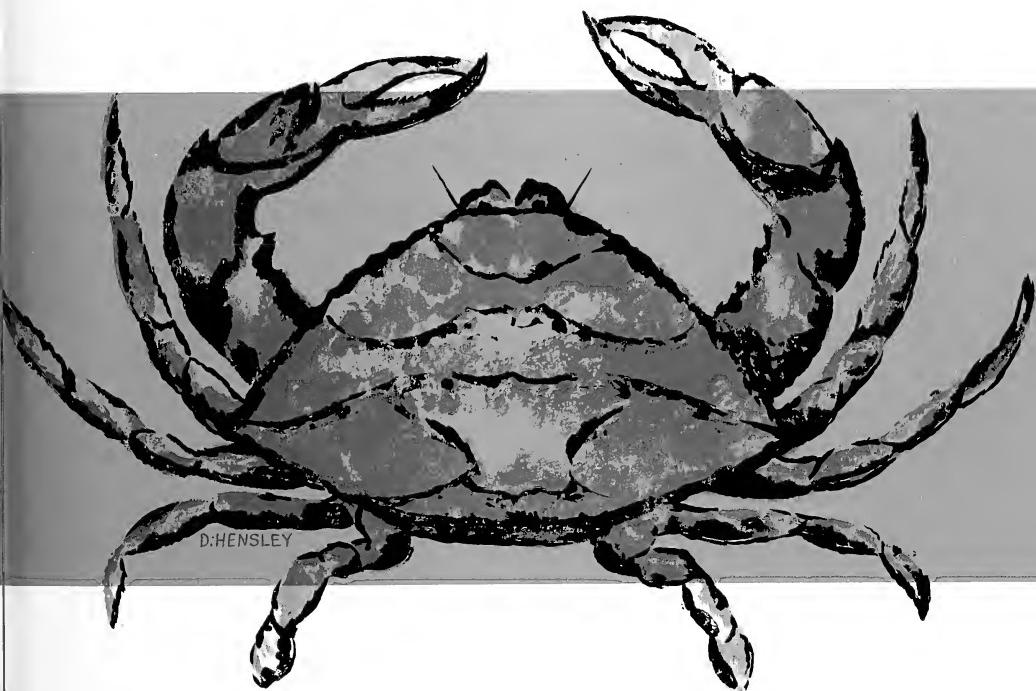
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The front cover is by Douglas C. Hensley.

A Museum of Science in Virginia*

In 1968, upon the recommendation of the General Assembly, Governor Mills E. Godwin appointed a Science Commission of five members to study the feasibility of establishing a science museum and to determine its "scope and financial requirements." Since that time, public hearings have been held by the Commission in various sections of Virginia to ascertain the need for a museum of science and the desires and thinking of the general public regarding the establishment of such a museum.

A committee from the Virginia Academy of Science has been active during the past year in attempting to find means for implementing a museum of science in Virginia. The findings of this committee will be submitted to the State Museum Commission for consideration.

On the suggestion of the VAS Committee, a Symposium on a Museum of Science was held on Thursday evening, May 8, 1969, at the Annual Meeting of the Virginia Academy of Science. The purpose of this Symposium was to have knowledgeable people from other museums speak to the members of the Academy and to have Academy members express their opinions of the kind of museum they would like their committee to support. Dr. Russell J. Rowlett, Jr., Editor of *Chemical Abstracts*, at Ohio State University, was Moderator of the Symposium. The panel was composed of the following people:

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Smithsonian Institute
Washington, D. C.

The first panelist, Mr. Hallock, spoke on "WHAT IS A MODERN MUSEUM—ITS OBJECTIVES AND PURPOSES." He stated that the concept of science museums has been changing during the past few years. In the old idea of science museums, there was much below the surface; however, new and modern museums have more above the surface in the way of educational exhibits in which people are actively involved. He explained how programs at the Center of Science and Industry in Columbus, Ohio, utilized these newer ideas in providing a modern museum facility.

The center, now five years old, has four museums under one roof—History, Health, Space Science and Industrial Science. It is sponsored by the Franklin County Historical Society, a private, nonprofit organization. The operating funds are derived from admissions, memberships, contributions and exhibitor sponsorship. Franklin County, through the Historical Society, donates funds for research, documentation and publication of historical information. The exhibits and facilities are valued at over two million dollars. Each exhibit is a separate unit and all exhibits are educational. They are designed to tell a story of the development, operation or specific aspects of a business, industry, association, or government department.

Classes from kindergarten through adults are offered on a wide variety of subjects such as, astronomy, meteorology, amateur radio, electronics, history and others. Guided field trips are scheduled from spring to fall to points of local interest. There are cooperative programs and activities with organized groups such as Girl Scouts, Boy Scouts, the Rock and Mineral Society and various engineering and technical societies. Saturday and Sunday programs highlight film classics and outstanding speakers on a variety of subjects related to science and history.

Community involvement has been the key to the success of the Center of Science and Industry. The volunteer program offers opportunity for adults and students to become involved. This provides personal reward as well as invaluable assistance to the Center. "Fun in learning," a key word at COSI (as the museum is known) is put into practice for all visitors. Here they can feel, hear and see.

The next panelist, Mr. Haynes, spoke on "WHAT IS THE PRESENT MUSEUM SITUATION IN VIRGINIA AND WHAT WOULD BE THE IMPACT OF A MUSEUM ON EDUCATION?"

His conception of a Virginia Museum of Science is presented in the following excerpts from his prepared remarks:

A Virginia Museum of Science should serve the entire state. One possible pattern is to establish a large central museum complex with smaller regional science centers placed in strategic locations throughout the state. One advantage to this concept is that initial modular development of the central museum could begin immediately, with additional modules being added to the complex in stages as monies become available.

The regional centers, until monies for permanent facilities are appropriated, could work out cooperative arrangements with school districts, counties, and cities to use existing facilities. Operational programs could be organized and financed by the Science Museum, with school divisions, counties,

* Summary of a symposium on Museums of Science held at the 47th Annual Meeting of the Virginia Academy of Science at Mary Washington College, Fredericksburg, Virginia, May 8, 1969.

or cities providing physical facilities and other resources that might be available, as their contribution. The regional science centers would always be a cooperative venture between community-school-central museum. Activities at these science centers would fall into at least four categories: enrichment, teacher education, general education, and information coordination.

In order to attain excellence in science education throughout the state, some agency must spearhead a complete mobilization, organization, coordination, and utilization of all human and physical resources of the scientific community.

A strong science museum could serve a supporting and catalytic role in bringing together and utilizing these resources throughout the state. The thrust of this effort would be to increase significantly the scientific literacy of the total population, which is extremely vital to the strength of our state and nation in a world that is becoming more and more science-technology oriented.

Virginia is rich in human and physical resources. With these forces in harness, scientific literacy would be increased to a level that would enable the state to be at the forefront of science, producing more than its proportional share of leaders for the nation, as it did in political leadership in the early history of our country.

Dr. Manning, the third panelist, spoke on "BRANCHES OF A MUSEUM—THEIR LOCATION, ORGANIZATION, AND GOALS." He stated that a State Museum of Science could share certain responsibilities with the National Museum but will have different goals and will emphasize different functions. A State Museum will not necessarily become a national repository but it may assume national prominence because of its operational procedures. There are over 5000 museums in this country today and perhaps it is obvious that organizations of museums are not necessarily comparable for there are no guidelines for museums.

A State Museum should have as its goals:

1. Documentation and cataloguing of the state's natural resources.
2. Interpretation of these natural resources to the citizens of the state.

Education should be the major goal and public support, interest and involvement must be developed and must be maintained.

The initial stages in the development of a State Museum should be those concerned with portions which are visible and useable by the public such as: botanical garden, planetarium, special exhibits area, children's area and traveling exhibits. Citizens need a place where they can obtain information on plants, mammals and other environmental resources and where they can deposit local collections so that they might be identified and used. Such a museum should not be organized by disciplines but should have a coordinated approach to the study of the environment.

Research centers should be developed near or adjacent to colleges or universities. These would provide educational programs at a much higher level than those provided at children's or exhibit museums. Research programs should be directive with specific means and goals and there should be well planned and centrally coordinated field programs.

During the discussion Dr. Rowlett suggested that the major industries in Virginia be contacted to ascertain if exhibits which they have in current use could be made available to the museum. He mentioned, in particular, the Virginia Electric and Power Company's nuclear reactor exhibit at Surry, Virginia.

As a result of the talks by the panelists and the discussion which followed, the group seemed to be in general agreement on the following points:

1. There is a need for the establishment of a Museum or Center of Science in Virginia.
2. The primary purpose of such a museum would be to serve the needs of education.
3. The main complex should be in a building housing several phases of science and should be located in or near an important metropolitan center.
4. Subsidiary units should be placed in strategic locations throughout the state.
5. Research centers should be located near or adjacent to colleges and universities.
6. Building and operating funds should be obtained from industry, private donations, foundations, organizations, admission fees, and state aid.
7. Involvement of industrial people in the community should be solicited. This involvement, as well as public support, is essential.

**REPORT OF THE
VIRGINIA ACADEMY OF SCIENCE
AD HOC COMMITTEE ON A MUSEUM OF
SCIENCE IN VIRGINIA**

Since its inception, the committee has held five meetings and sponsored a Symposium at the Annual Meeting of the Virginia Academy of Science in Fredericksburg, Virginia, on May 8, 1969. As a result of these meetings and the Symposium, a summary of which is published in this issue of the Virginia Journal of Science, the committee makes the following recommendations for presentation by the Academy to the Governor's Study Commission on a Museum of Science in Virginia.

1. A central Museum of Science be established in the Richmond area. The Richmond area center is to develop and administer a statewide system (mobile exhibits, lectures, films, etc.).
2. Education should be the major goal of the museum and public participation should be emphasized. Its goals should include:
 - a. Documentation and cataloging of the state's natural resources.
 - b. Interpretation of these natural resources to the citizens of the state.
3. That initial consideration be given to establishing a planetarium and a botanical garden as starting units.
4. The following Richmond area sites should be given consideration:
 - Maymont-Byrd Park area
 - State-owned Elko tract
 - Broad Street Station area
5. The major industries in Virginia be contacted to ascertain if current exhibits would be available to the Museum.
6. The Council of the Virginia Academy of Science enthusiastically endorses the concept of a Museum of Science for Virginia and offers its support and assistance to the Study Commission in implementing this concept.

**VIRGINIA ACADEMY OF SCIENCE
Future Meetings**

1970

Virginia Commonwealth University
and
University of Richmond
Richmond, Virginia
May 5-8, 1970

1971

Virginia Polytechnic Institute
Blacksburg, Virginia
May 11-14, 1971

1972

Virginia Military Institute
and
Washington and Lee University
Lexington, Virginia
May 2-5, 1972

1973

50th Anniversary
College of William and Mary
Williamsburg, Virginia
May 1-4, 1973

Maurice B. Rowe
Commissioner

*Virginia Department of Agriculture and Commerce
Richmond, Virginia 23209
Received May 8, 1969*

Agriculture + Science = Abundance

Man's search for plenty has succeeded in the United States to a far greater extent than in most countries. Today, food scarcities are causing millions of people in many areas of the world to either starve or suffer from the lack of a proper nutritional diet. Many backward nations still cling to a very primitive type of agriculture, using the same kind of farm implements their ancestors developed thousands of years ago, while spectacular increases in production created by science and improved technology are changing the concept of farming in our highly specialized industry of agriculture.

This industry of agriculture, or "agri-business," consists of three important segments—farm producers; their suppliers; and the processors, marketers and retailers of farm products. This giant industry employs 8 out of every 15 people in the U. S. total labor force. Its capital assets—presently estimated at \$298 billion dollars—are larger than those of all other major industries combined. They are equal to two-thirds of the current assets of every corporation in the United States, or about three-fifths of the market value of every corporate stock listed on the New York Stock Exchange.

Our present abundance—which is largely taken for granted by many Americans—didn't come about by accident. It is mainly the result of the application of twentieth century science to agriculture. A vast array of scientific knowledge and technology is behind the increased efficiency which has made our food supply the best, safest, and most abundant of any nation in the world today. In recent years U. S. farm productivity has made more gains than at any other time in our nation's history. Its rate of increase during the past decade of 75 per cent per man-hour is more than double the growth rate of industry.

The incredible speed with which additions to man's scientific growth are occurring has been powerfully illustrated by the construction of an imaginary graph designed to cover the entire spectrum of human knowledge. If the first three inches of this graph were arbitrarily chosen to depict everything man knew up to the steam age, another twelve inches would be required to reflect the gains in knowledge from the time of the steam engine to the atomic bomb. But, if the *progress that has taken place since then in our time* was added, the graph would have to be made taller than the Washington Monument!

Throughout world history, revolutionary changes in our society have taken place as a result of scientific advances, most of which have either directly or indirectly affected agriculture. These events date back to the earliest period of life on earth, when man made such momentous discoveries as fire, the wheel, and the cultivation of plants and domestication of animals.

Scientific developments progressed slowly for thousands of years. In fact, no really significant improvements were realized until our civilization reached the stage defined by historians as Early Modern Times—a period which lasted from roughly the middle of the fifteenth century through the end of the nineteenth.

During this period, many scientific landmarks were established, including: the theory of the universe; the laws of mechanics; the foundations of modern chemistry; proposal of the atomic theory; the theory of evolution; classification of the elements; and the isolation of radium. Great scientific gains in farming were also made during this period, highlighted by the invention of the reaper and the cotton gin. Other agricultural improvements of this era included the horse-drawn cultivator and planting drill, new root crops, and planned animal breeding.

As outstanding as these early achievements were, they marked only the beginning of the revolutionary changes destined to take place during Modern Times (1900—present). The advent of the twentieth century saw such innovations as the first usage of chemicals to treat disease, development of the theory of relativity, discovery of penicillin, and the splitting of an atomic nucleus. By 1942 the first successful nuclear chain reaction had taken place, and in the late 1950's man began the conquest of space with the launching of the first satellite. Advances since then have been too numerous to mention, but the success of the recent Apollo flights undoubtedly presages the actual exploration of the moon—and the universe beyond.

Without question, man's ability to utilize both nuclear and solar energy will continue to bring about tremendous changes. By the same token, advances in agriculture and soil science will also have a definite bearing on the future of mankind by bringing about increases in the supplies of food-energy.

Although most scientific advances are generally first put to industrial usage, they usually also have a

profound affect on agriculture. Today's highly efficient agricultural practices to which we owe our present abundance have made farming a scientific vocation that has reached a higher level than ever before. In fact, no other industry has experienced so great a growth and development. Agriculture is now generally recognized as being the economic basis of practically every other industry and business throughout the diversified realm of commerce.

Innovations such as modern tractors, selective breeding, soil improvement, scientific marketing, and refrigerated transportation have transformed our farmers into practical scientists. They must be able to recognize scientific information, and know how to put it to use. Today's successful farmers must be well abreast of the latest fertilization concepts, practice approved systems of crop rotation, understand irrigation principles, and know how to till various types of soil. Knowledge involving chemistry, biology, bacteriology, entomology, pathology, veterinary medicine, and the like, is very necessary in order for them to effectively combat insect pests and diseases that can ravage both crops and livestock. An understanding of scientific breeding of stock is also most important. In addition, as efficient managers they must have diversified abilities and skills in such areas as business management, accounting and salesmanship. Thus, *man's advances in science and technology bear a direct relationship to the progress that has been made both in industry and agriculture*. The high social status and economic living standards enjoyed by the majority of the world's civilized nations today could not have been achieved without this progress in science.

According to USDA's 1968 Yearbook of Agriculture, "Science For Better Living," scientific agriculture has made and continues to make the following major contributions to this country's abundance:

*Multiplied the nation's manpower by increasing productivity to release millions of laborers from farming to supply rapidly rising industrial demands for manpower.

*Provided sharply lowered food costs relative to income, as reflected by a drop in the percentage of consumer take-home pay spent for food from 40 per cent in 1900 to 22.2 per cent in 1950 to the present 17.7 per cent. These economic gains have reduced inflationary tendencies and provided a larger market for industry.

*Scientific agriculture has sustained our abundance by its steadily growing purchases of goods and services—despite the rapid drop in farm population. Of the 1967 gross farm income of nearly \$49 billion, farmers spent about \$34 billion for production supplies, plus additional amounts for the same consumer products and services that city people buy.

*The expanded export capability made possible by scientific agriculture has bulwarked the nation's economy and brought back "sales for dollars" that aid in the overall balance of payments situation. In fiscal 1967, foreign markets took \$6.8 billion of agriculture's products, while commercial exports or "sales for dollars" totaled \$5.2 billion.

*Scientific agriculture is proving to be the world's number one weapon in the war on hunger, and is the basis upon which future world economic development rests. U. S. exports of grain and other commodities are helping under-developed nations whose own agriculture does not produce enough food for their own needs.

*Scientific agriculture is the keystone of prosperity in rural America, which faces a grave challenge because of the continuing migratory trend from rural to urban areas. Agriculture remains the major industry of rural areas, and is the core around which the rural economy revolves.

Although an increasing number of marginal farm operators lack both the capital and the know-how to utilize the latest scientific innovations, and are being steadily forced out of business by the low profit picture, many smaller units are merging into larger operations whose high productivity now accounts for the great majority of U. S. farm output. According to USDA, since 1950 acres planted with crops have shrunk over 10 per cent, while crop production has expanded well over a third, and production per acre has risen by over 71 per cent.

Here in Virginia, we in the Department of Agriculture and Commerce are charged with the responsibility of serving all segments of the state's industry of agriculture, and we also ultimately serve consumers through many programs that are definitely consumer-oriented. Conservative estimates place the total contribution of Virginia's industry of agriculture to the state's economy at nearly three billion dollars. In the broad sense, agriculture is unquestionably the largest business in Virginia, and is steadily growing.

Providing at least partial employment for an estimated 446 thousand Virginians, those employed in agri-business account for over one-fourth of the state's civilian labor force of 1.6 million, and are 30 per cent greater than the total of 344 thousand workers now employed in the manufacturing industry. An estimated 50 per cent of Virginia's manufacturing firms are farm or soil based, meaning that they are dependent on agriculture or forestry production, and over 25 per cent of both wholesale and retail firms depend upon agriculture for their existence.

The profit-eroding cost/price squeeze that plagues the nation's farmers is also a problem in Virginia, and department personnel are cooperating with agricultural groups throughout the state (in-

cluding state and federal agencies and farm commodity groups) to improve their economic status. We have an active market development section whose main purpose is to help expand and improve existing markets, with special emphasis on the development of foreign trade. During the 1967-68 fiscal year, a total of nearly three and a half million dollars worth of new agricultural export business was realized as a direct result of these efforts.

With the steady growth of our population, continued scientific research will become increasingly important to assure a constant, wholesome, and adequate food supply in the years to come. With more and more productive land being utilized for dwellings, highways and industrial plants, all types of agricultural production will have to be increased. Greater yields will be needed from crops, and animal production per pound of feed will also have to be increased. Pest control methods will have to be improved in order to further reduce losses in this area. Scientists will also need to devise better methods of food storage to increase protection from deterioration.

Scientific agricultural improvements of the future will stem from many areas that are hard to visualize now. Additional knowledge about both crops and pests will be gained from instruments in the sky contained in either airplanes or satellites. Com-

puters will be extensively used, and some farm equipment may actually be guided by computer programming or other sensing devices. Future tractors may have electric drives powered by fuel cells or more efficient storage batteries, and possess many automated innovations and accessories.

Irrigation will be carefully studied and performed more extensively, possibly utilizing radio control units, and the air itself may even be fertilized for maximum yields. Furthermore, the bumper crops produced by these new concepts may actually be harvested by computerized machines equipped with ultrasonic sound to strip ripe produce from plants and trees. Dairying may also become a "push-button" operation, with herds of cattle and other livestock housed in special high-rise structures.

These, and many other developments that tax the imagination, will likely become future realities. However, nothing good was ever achieved without effort and planning. There is a tendency toward complacency that must be overcome in order to assure that agriculture will rise to meet the enormous future demands for food and fiber. Our present reservoir of agricultural research is certainly not unlimited, and this vitally needed technology must be developed to the fullest if our nation is to increase its farm output and remain the world's agricultural leader.

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The Acculturation of the Psychedelic Experience*

A major premise of this paper is that Western society is undergoing an energetic transformation, in which the psychedelic experience and its social and psychological implications may be seen as a major contributory factor. How the shift occurred in society from an active resistance to an albeit reluctant acceptance of this phenomenon is difficult to determine, but one fact is clear: The psychedelic experience exists. It has influenced an entire generation in the way they think, dress, talk and communicate. It has created a new industry of music and art and verbal expression and has stimulated activity in such fields as fashion, decor, interior-decoration and design. It may not be an exaggeration at this point if I suggest that the psychedelic experience, with all its ramifications and implications, is one of the most significant phenomena in Western society within recent times.

Any background to our understanding of this phenomenon must take into account the fact that there has been, within the last decade or so, a very gradual but nonetheless perceptible shift in the dominant values of Western society. There has been an increasing emphasis on such matters as personal growth, on the liberation from the excessive constraints of certain socio-economic roles which are felt to be somehow inauthentic or inappropriate; on the right of the individual to chart his own course in a world of increasing conformity and technological dependence, and on the necessity of the individual to express himself in the light of new, humanistically based concepts of social organization and management. Within the discipline of psychology, as we begin to take cognizance of these tendencies, we notice a growing interest and emphasis on the use of "sensitivity training": methods that have as their basis the idea that people can be open with each other, can be more authentic, and can become more aware of the impact of certain behaviors, and thereby guard against the more negative ones. In other words, an increase in individual self-awareness has taken place in recent times so that people today are more responsive to the professional possibilities for them to create and design social organizations which elicit more of the potential of each individual.

Parallel to what we might term this humanistic

shift in sensibility goes the realization that our technology, the fruit borne from the womb of Western civilization, is beginning to control us. Most of us are subject in one form or another to the impact on our nerves of the vast "military-industrial establishment," and this is reflected in different degrees of personal and social anxiety. Such fears, the conscious as well as the unconscious, are often manifest around the way we talk and react to such specific issues as "defense" spending, the proposal to develop a national computer bank, the electro-chemical control of behavior, or other so called "advances" which technology heralds from time to time.

Against this subtle interplay of growing humanistically based needs felt to be good and the technologically based fears felt to be bad, the psychedelic drugs have made their appearance.

Hence, the question "Why take drugs?" has to be raised and answered within the context of the foregoing background remarks. Yet the question itself is all but rhetorical at this point, for the background would seem to answer directly and make the question seem almost superfluous. I think this point can be appreciated more easily if we examine some of the conclusions reached by investigators in this field.

"Even the briefest summation of the psychological effects of these drugs would have to include the following: Changes in visual, auditory, tactile, olfactory, gustatory, and kinesthetic perception; changes in experiencing time and space; changes in the rate and content of thought; body image changes; hallucinations; vivid images—eidetic images—seen with the eyes closed; greatly heightened awareness of color; abrupt and frequent mood and affect changes; heightened suggestibility; enhanced recall or memory; depersonalization and ego dissolution; dual, multiple, and fragmentized consciousness; seeming awareness of internal organs and processes of the body; upsurge of unconscious materials, enhanced awareness of linguistic nuances; increased sensitivity to non-verbal cues; sense of capacity to communicate much better by nonverbal means, sometimes including the telepathic; feelings of empathy; regression and "primitivization"; apparently heightened capacity for concentration; magnification of character traits and psychodynamic

* Presented at the 46th annual meeting of the Virginia Academy of Science in Roanoke, Virginia, as part of a "Symposium on Psychedelic Phenomena" sponsored by the Section of Medical Sciences, May 10, 1968.

processes; an apparent nakedness of psycho-dynamic processes that makes evident the interaction of ideation, emotion, and perception with one another and with inferred unconscious processes; concern with philosophical, cosmological, and religious questions; and, in general, apprehension of a world that has slipped the chains of normal categorical ordering, leading to an intensified interest in self and world and also to a range of responses moving from extremes of anxiety to extremes of pleasures." (1)

Now, given such a description, which broadly sketches the range and scope of the psychedelic experience, the answer to the question of why people take drugs seems rather obvious. In large measure the psychedelic experience holds out a promise—or at least suggests the possibility—that each individual has at his disposal the means whereby he may transcend much of the boredom and sense of sterile mechanicalness which causes anxiety within himself and may be traced directly to his having to live and work in an overwhelming technologically based social atmosphere. This is an important consideration in any examination of the psychedelic phenomena in our society and is often ignored or overlooked by well-meaning people who are primarily concerned with drug use and abuse. Certainly, the problem of drug abuse is a vast one and requires careful analysis, but the fact remains that any in-depth study of this question must come to terms with the shifts and changes which have taken place in our psychological and social life within recent times. Questions and doubts of an existential kind are being raised by an increasing number of persons at all levels of our society who wonder where our so-called "technological progress" is leading us. These concerns are nowhere more articulated today than they are by our youth, both in terms of their involvement with the psychedelics and in their attacks on the structure of our present Western establishment. This is not to exclude the older generation, however, for whom a corresponding questioning and answering is going on, only in a much less manifest form.

An obvious extension of this line of inquiry might take into account the statistics of psychedelic drug use at the present time. But it is very difficult to identify statistically with any real degree of accuracy what the actual usage of psychedelic drugs is at this time. I would hazard a guess, however, that the incidence of their usage is much greater than our statistically based inferences would seem to suggest. Much more revealing are the casual observations of the mass media, which periodically indicate that well-known social and political figures have taken these drugs and did so for a variety of different reasons and with a variety of different effects. For here we find prominent cultural figures, role models and opinion-makers, identified publicly with the psychedelic experience. It is only an extension of our ordinary common sense to accept the facts that this information will have some effect on the thinking of those who read about it

and who are likely to be influenced by the actions of men of social prominence or power. Such considerations as these, point to areas of interest where a perceptible socio-psychological change is taking place within the social fabric of Western society.

The Current Ideologies

When we survey the current range of attitudes and activities of people associated with the Psychedelic movement we find a number of parallel viewpoints which co-exist simultaneously. In bold outline, what we find in the contemporary scene are viewpoints which tend toward ideologies of one kind or another in that they seek to confirm prior assumptions about psychedelic drugs. In other words, these viewpoints embrace those facts already known about the clinical and nonclinical use, abuse and significance of the drug experience. What is not always appreciated is that the various labels that have been used to describe these drugs—hallucinogenic; psychotomimetic; psychedelic; consciousness-expanding, et al.—are not adequate to explain the full range and effects these drugs have on the mind.

All of these labels betray a set of prior assumptions regarding the nature of the drug experience, including its likely short and long-range personal and social significance and its possible dangers. In other words, the choice of label represents a pre-scientific or pre-religious or pre-legal commitment, which can and does determine what kind of research, what frequency of drug use, and what psychological and social implications follow in terms of individual behavior.

One example of this can be found in the current medical viewpoint which includes the administration of these drugs for therapeutic purposes but has recently become concerned with some possible genetic side-effects these drugs may have. For a number of years the medical position, or more precisely, the psychiatric position on these substances was that they produced hallucinations, hence their label "hallucinogenic." This position evolved naturally into the "psychotomimetic" position, which sees these substances as producing psychotic-like symptomatology. Most recently, the emphasis has shifted into the area of genetics, particularly so with reference to possible chromosomes damage, but so far the results based on studies in this area are scientifically inconclusive and much work remains to be done. There is also, at this time, an interest on the part of other researchers into the neurochemical pathology resulting from the ingestion of psychedelic drugs, though it is still too early to evaluate the significance of this line of research. It is clearly of the utmost importance that we know very accurately whether the ingestion of these drugs causes cellular or neurochemical damage. But it is interesting to note, however, that the medical position at the present time is *primarily* directed toward pathology, the little therapeutically oriented medical research with psychedelics having received relatively little attention or funding over the past few years.

Within a spectrum of viewpoints or ideologies now associated with psychedelics, we have to recognize the considerable voice and influence of the medical profession's definition of the specificity range and type of activity of these drugs. We cannot ignore medical opinion in any serious attempts to understand the different dimensions of the psychedelic ideologies.

A second viewpoint, already somewhat less visible in the light of recent mass media emphasis on genetic damage, is a position that might be called psychologically eclectic. This viewpoint emphasizes the extent to which these substances can be used by individuals to help them more fully comprehend the nature and scope of their own mental life. Used in this way, psychedelic drugs may be considered "tools" for increasing our understanding of certain phenomena in depth psychology, both Freudian and Jungian, and in such fields as ESP, creativity, religious experience, and the psychological dimensions of the dying process. This viewpoint is represented by a large group of people from different professional backgrounds and experience—psychologists, theologians, men-of-letters, poets, thinkers, designers, artists, and ordinary persons with an intelligent interest in psychological phenomena. It should be noted in this connection, however, that the prevailing social, legal and medical constraints on the use of the drugs has made it all but impossible for serious research to be undertaken in these areas. Nevertheless, much if not most of the informative and objective literature we now have in the psychedelic field has come from individuals who essentially represent this point of view. The Masters and Huston book, *The Varieties of the Psychedelic Experience* (1) is one such example, and admirers of William James will readily understand the philosophical inheritance as well as the quality of scholarship underlying this inquiry.

Easily the most obvious and most social anxiety producing ideology of the psychedelics is what we might term the "Fun-and-Games" perspective. This is really the focal point of the youth culture and college populations and represents the best example of what I refer to as the psychedelic acculturation process. What we see now is nothing less than rapid acculturation of a new intoxicant. A process is taking place wherein a "new" drug has been discovered—or an old one revived—and is rapidly and with a great deal of fanfare and social and personal dislocation being incorporated into the larger culture. This is very obvious in the case of marijuana, but it is also true of LSD and some of the lesser known psychedelics. It is difficult to gain a cultural understanding of this kind of phenomenon while we are still enmeshed in the acculturation process, but it may be rewarding if we take a look at the picture at a more general level. There is, for example, an interesting study on the choice of intoxicants within a small community in India by the Scottish psychiatrist, Professor G. E. Carstairs (2). Professor Carstairs observed that the subcultures that formed around the use of Indian hemp and alcohol, the two dominant or most

popular intoxicants, betrayed very definite differences in such points of view as metaphysical outlook, self-image, occupation and social status. It appeared as if the choice of intoxicant was somehow related to a larger gestalt and one that represented a very different psychological and social outlook. Another very interesting aspect of this study was the observation that there was a continuing conflict and cross-criticism between the two groups.

So when we see a growing edge of conflict between groups of people (or generations) with different intoxication experiences we might timidly extrapolate to our own situation to see if this helps to clarify what is going on in our own society. Seen in the light of the foregoing and from the point of view of someone witnessing the process of acculturation of the psychedelics into the fabric of Western society, the psychedelic experience has produced ideologies and ideologists, groups and factions, religions and anti-religions, charisms and followers, repression and rebellion, though it has yet to produce much clear, sustained good thinking.

In all of this, the role of the mass media in eliciting, stimulating and provoking interest, both pro and con, cannot be overstated. It is now a mute point whether, as Marshall McLuhan has suggested elsewhere, the media make the news or simply report it. But what is certain, however, is that much of what reaches us in the form of factual information is fanciful invention. Yet the power of the media over the message which both informs and incites curiosity and imitation is very great, and will have to be taken into consideration when the history of the psychedelic acculturation process finally comes to be written.

Provoked Mysticism

It is an interesting fact that mystical and religious themes play a central role in so much of the youth culture the mass media have popularized. Along with the wide-spread use of psychedelic drugs we see an apparently increasing interest in other spiritual approaches or methods of self-discovery. Some of this interest can be explained by the fact that many people have experienced strongly religious or mystical states through LSD and the other powerful psychedelics. What has not been sufficiently appreciated is that these states are usually experienced as quite discontinuous with ordinary life. In other words, most individuals who have experienced these states have been unable to incorporate these insights into their daily lives with any great degree of ease. This has been reported subjectively as the problem of psychedelic "re-entry." And in many cases, this realization occurs long after the initial impact of the psychedelic experience has faded and been verbalized into memory. Yet it is the fact of this realization, when experienced sincerely and honestly, that has in many instances steered individuals in the direction of a search for other spiritual approaches that at least in principle, aim at the same goal: Full psychological and spiritual development.

So we see a growing awareness of the existence of other approaches which are less dangerous, have potentially less physical or physiological side-effects, and which through repeated conscientious and sincere application may have some long-range positive effects on personality and psychological life. Much of the current emphasis on meditation and Gurus, etc., is in this direction and although much of it seems silly and faddish, there is an authentic vein running through this that represents the aspirations of people to reach beyond the experience of their ordinary lives in order to look for some meaning, higher purpose, or more significant reality.

That this search represents an authentic "drive" in a deeply psychological sense is only beginning to be understood by the professions of psychiatry and psychology. That people will resort to a variety of methods and techniques for "self-actualization" with more or less difficulty, and with more or less success, is also clear when one examines the history of what Masters and Huston have called "Provoked Mysticism."

Provoked mysticism represents an effort to achieve a state of mystical consciousness through some direct intervention of a physical kind. Through the use of certain plants and drugs, through fasting, dancing, breath control and other methods there is a direct effect on the human nervous system that can and does produce experiences that have religious or mystical dimensions. The history of this kind of experimentation has been documented increasingly in recent years with the findings that these provoked experiences have a definite physiological effect on brain sugar levels, on CO_2 concentration, and in general on biochemical events that affect consciousness.

So one important inference from this kind of documentation is that direct access to mystical states requires a direct provocation through the use of some naturally occurring vegetables or some strong physical intervention in the body. However, it cannot be overlooked that the tradition of provoked mysticism has almost always required some highly ritualized sacramental context in which the provoked state of consciousness is obtained. In other words, in those cultures and religions which employ these sacramental substances or exercises, there is a great deal of protection and knowledge in the hands of those people responsible for producing or giving these experiences. A primary requirement underlying the use of provoked mystical methods is a powerful sacramental tradition administered through non-arbitrary authority. The strictness of these requirements is based on the understanding that an unprepared person having direct access to mystical states may become lost in an unusual kind of pathology. This pathology cannot be fully explained in the traditional categories of psychiatry, although the phenomena may be described that way through the lack of more adequate terminology. But, in any case, a premature or uncontrolled access to mystical states may produce a psychosis in an individual who has not been prepared to relate this experience to his or her ordinary life (3). In other words, there is noth-

ing in the person as a result of preparation or discipline which can make the connection between the ordinary states of consciousness and the new, super-conscious ones. Consequently, the experience of the super-conscious can be terribly dislocating. At best, the provoked psychedelic mystical experience may have a very strong initial effect and then gradually disappear as ordinary life re-asserts itself. At worst, the experience can create a situation in which the person is unable to regain the connection between the supraconscious state and his familiar ordinary one. This state of confusion frequently results in a deterioration of the person's ordinary affairs to the point where he may have to be hospitalized or where they may run into conflict with established authority. Much of what is usually considered to be a "naturally occurring" psychosis is a manifestation of this discontinuity which occurs spontaneously. Consequently, in those religious traditions which employ powerful experiences of this type there is a great deal of qualified supervision, a great deal of screening of potential candidates for these experiences, and quite often a good deal of secrecy. All of this stands in marked contrast to the style of wide-spread exogenous use of psychedelics in the United States and the general conditions and circumstances in which these drugs are taken.

We cannot divorce this analysis of provoked mysticism from some analysis of the social conditions in which the drugs are used, nor from the social reactions and social anxiety that these drugs have created. This social anxiety is not based primarily on medical fears of genetic damage but rather on a basic fear of the exploration of inner life. The medical fears operate in the service of these other fears in that the psychedelic experience threatens the ego of an externally oriented and technologically based society. These drugs produce a certain kind of passivity which is not in vogue in contemporary Western society as well as engender a certain inability or unwillingness on the part of some of those who use them to deal with the problem of how to get from 9AM to 5PM five days a week. Hence, the problem of continuity between higher states of consciousness and the demands of ordinary life cannot be solved so simply by either the drugs or society.

At the present time there is an increasing need for individuals to discover or more precisely, re-discover spiritual and religious disciplines which aim toward the development of higher states of conscious awareness and which prepare people inwardly for these kinds of supraconscious experiences.

The question of suitable preparation for the psychedelic experience is a question that has been recognized by many traditions that have devoted themselves to the development of man's potential. What we require is a perspective through which the psychedelic experience can be understood within a much more disciplined and persevering spiritual life. If we are serious about this phenomenon, if we are really concerned with the impact of the psychedelic drugs on this society, if we are able to consciously guide this acculturation process, we have to be much more open to the possibilities inherent in

traditional spiritual disciplines. This openness has to be reflected in our educational and social planning which will have to take into account the increasing interest and need for a re-discovery of the importance of the inner life and the "ways" of personal growth. This seriousness will also have to be reflected in a greater openness to research which seeks to discover how the psychedelic drugs may help us to learn more about the structure and processes of mental life.

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Especially for Science and Mathematics Teachers

Ideas
Questions
Opinions

Earth Science Projects For Teachers

1. Molds and Casts of Fossils

A large portion of fossils are preserved only as mold or casts. The following project is designed to give the student a greater appreciation for the preservation of traces of organisms. Most students are familiar with fossils such as dinosaurs, clam shells, and perhaps brachiopods. Many of these are preserved essentially in the unaltered state; that is, you may have the actual bone from a dinosaur. However, many invertebrates and plants are preserved only as molds or casts. Outlined below is a project to illustrate the formation of molds and casts.

The following materials are required: plaster of paris, liquid latex, petroleum jelly, 1 quart and $\frac{1}{2}$ gallon milk cartons, single edge razor blades, plastic bucket, large spoons, hat pin, and suitable fossils.

Procedure and discussion: Step 1—Cut the milk carton to form a shallow pan. Be sure the pan is deep enough to cover the fossil.

Step 2—Coat the fossil with an ample layer of petroleum jelly.

Step 3—Prepare enough plaster of paris to fill the carton. The consistency should be like thick, whipped cream.

Step 4—Place the fossil in the carton and cover with plaster of paris. This step illustrates the burial of a shell by sediments in the ocean basins, rivers, or lakes. The plaster will harden in about 24 hours. This illustrates the lithification of sediments to form a sedimentary rock.

Step 5—Using a hat pin and razor blade, remove the fossil from the plaster. In nature, circulating ground water may accomplish this task. You now have a mold of the shell.

Step 6—Fill the mold with liquid latex. DO NOT SHAKE THE BOTTLE. Twenty-four to forty-eight hours are required for the latex to dry. The exact time will depend on the thickness of the cast. The latex forms a replica or cast of the fossil much as circulating solutions do in nature.

2. Classroom Stream Table

A stream table can illustrate many features of erosion by running water and certain depositional

Ideas, Questions, and Opinions is planned especially for secondary, intermediate, and elementary science and mathematics teachers, and will appear regularly in the *Journal*. We solicit contributions which will be of interest to these teachers and which will be of value in furthering scientific and mathematical education. Correspondence should be addressed to Virginia C. Ellett, Mathematics and Science Center, 4225 Old Brook Road, Richmond, Virginia, 23227.

features. In order to be useful, a stream table need not be elaborate. The following list of materials may be purchased for less than \$15.00.

Materials List		
$\frac{5}{8}$ " plywood	1 piece	4' \times 4'
	2 pieces	4" \times 4"
	2 pieces	4" \times 3' 11 $\frac{1}{2}$ "
1 lb. 1 $\frac{1}{2}$ " galvanized finishing nails		
1 tube caulking		
1 quart of marine or boat paint		
$\frac{3}{4}$ " plastic tubing (enough to reach the proposed drain)		
$\frac{1}{2}$ " or $\frac{3}{8}$ " plastic tubing (enough to reach from faucet to stream table with plenty of slack)		
2 wood blocks 2" \times 4" \times 4"		

Construct a 4' by 4' tray of the plywood. Space the nails every 2 inches. (Screws spaced every 2 $\frac{1}{2}$ inches may be substituted for nails.) Drill a $\frac{3}{4}$ " hole $\frac{1}{2}$ " above the base at one end and insert the $\frac{3}{4}$ " plastic tubing. This will serve as a drain. Caulk all joints and around the drain. Allow 24 to 48 hours for drying. The tray may now be painted with a suitable marine or boat paint. Several coats of paint will increase the useful life of the stream table.

The water supply system consists of plastic tubing with a sprinkler head connected to an ordinary water faucet.

Prepare about 5 gallons of clean sand grain size from 0.5 to 1.0 mm. Cover the $\frac{2}{3}$ of the table away from the drain with sand, sloping from the end board toward the drain. Elevate the end away from the drain 2 to 4 inches with the wooden blocks. The table is now ready.

Experiments:

(a) Stream meandering—Form a small, slightly curved channel about $\frac{1}{4}$ inch deep in the sand. Place the sprinkler over the head of the channel and turn on the water. After several minutes, the following stream features will begin to develop; meanders, slip-off slopes, and uncut banks. With a little practice using chips of wood and a watch, the velocity of the stream can be measured.

(b) The relationship of slope to stream formation may be investigated by changing the inclination of the stream table.

(c) Delta formation—Small deltas form at the mouth of the stream in the settling basin near the drain. With the use of multicolored sand, various beds of the delta can be seen.

(d) Effects of water on materials of different re-

sistance—Small pebbles can be buried in the sand to represent materials of varying resistance. The stream will cut down to the pebbles and then begin to curve around them to form a meander.

With a little imagination, more elaborate experiments can be developed by the teacher to illustrate wave erosion and knob and kettle topography.

3. Smoking Volcano for Elementary Grades

The construction of a smoking volcanic model is very easily accomplished by molding a mound of moist sand about 18 inches high into a conical shape. Make a depression 3 to 4 inches deep in the top and fill about half full with baking soda. Add about one cup of vinegar and you have an instant smoking volcano.

4. Demonstration Artesian Well

Many students have seen a naturally flowing well and have wondered why it flows. A model of this natural situation is very easily constructed in the laboratory.

The first step is to construct a rectangular box about 6 inches wide, 3 feet long and 18 inches high. One of the long sides should be constructed of window glass or heavy transparent plastic.

Line the box with fine sand, beginning at the base at one end and forming a concave surface reaching the top at the opposite end. Cover the sand with a 1 inch layer of modeling clay. Seal the clay with paraffin wax. Place a 4 to 6 inch layer of medium-grained sand over the clay. Cover this sand layer with another 1 inch layer of clay. Pour water gently over the layer of medium-grained sand until the water table in the sand is within 1 inch of the surface. If the water is colored with food coloring, the illustration is more dramatic. The box is now ready for use.

Near the upper part of the concave slope, insert a 3 inch plastic straw about 2 inches, being careful not to clog the straw with clay. Water will rise in a straw and perhaps flow, depending on the placement of the straw.

Next insert a 4 inch straw on the lower part of the curved surface. The water should flow until the water has been lowered to the level of the straw.

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QUESTION

What Triggers the Nuclear Reaction During the Birth of a Star?

In recent years astronomers have been able to sketch in a number of details in the probable evolution of stars. A number of other facets of the theory remain obscure. Just as a number of ideas in the past about the evolution of stars have been shown to be incorrect, there may be serious flaws in current con-

cepts. The present concepts give an account as follows.

The evolution of a star depends rather critically on its mass. It has been shown that stars more massive than about 100 times the mass of the sun have intrinsic instabilities which probably prevent even their formation. On the other hand, stars which are less massive than a few percent of a solar mass cannot even start internal nuclear reactions. At the present time there is no known reason why stars down to the mass of the planet Jupiter cannot exist. Several objects forming binary systems with masses two or more times the mass of Jupiter have been discovered because of the gravitational disturbances they produce on their more massive (and hence brighter) companions.

In a way not completely understood at present, a cosmic gas-dust cloud under the right conditions and of the right size will collapse into a low temperature, but briefly luminous object called a protostar. This protostar continues contracting until its central temperature is high enough to start nuclear reactions. The speed of contraction is greater for more massive stars. For the smallest stars (called black dwarfs), nuclear processes never get started, and the star really never gets out of the protostar stage, but simply keeps contracting and radiating at a low temperature. The contraction times for black dwarfs, however, are very long, lasting for tens of billions of years.

For stars which are massive enough to have internal nuclear energy generation, the process of contraction stops once hydrogen begins to be fused into helium by thermonuclear reactions in the core. For every star of a particular mass above the critical amount, the contraction is stopped, and the hydrogen "burning" is started at a particular stage of radius, luminosity, and surface temperature. The rate at which hydrogen is used up in the core is also a function of the mass. More massive stars burn hydrogen faster. As the chemical composition of the star changes, the star becomes more luminous and larger than it was at the beginning of hydrogen burning. As soon as all of the hydrogen in the core is used up, the zone (shell) where thermonuclear reactions occur begins to move outward, and the core contracts. The outer radius of the star increases further, and the surface temperature decreases, but the core gets much hotter. After this shell-burning stage, the star enters the red giant stage. The core further heats and collapses, and finally elements other than hydrogen begin burning. Then at one point helium begins to burn in a so-called flash phase. This heats the star up further without changing its luminosity very much.

At this point it is not clear what the course of stellar evolution is. If the star is to become a small hot star (white dwarf), then its mass cannot exceed about 1.3 times the solar mass and so some form of mass-loss must be provided for the more massive objects.

Once in the white dwarf stage, no further thermonuclear reactions occur, and the star is simply shining from surface cooling of energy conducted up

from the core where it was stored during the red giant phase. The cooling-times are quite long, on the order of tens of billions of years.

At one time, it was thought that every star went through a supernova phase at the end, but it appears that this is too dramatic. It appears that the star will eventually cool off completely and become

a dark object representative of a more massive variety of black dwarf.

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Communications and Reports

LADLEY HUSTED 1906-1969

Ladley Husted, for many years a well known and respected member of the Department of Biology at the University of Virginia, died on 26 March 1969.

Mr. Husted was born in Wayne County, New York on 30 September 1906. He was awarded the B.A. degree by Oberlin College in 1928 and the following year he served as assistant in plant pathology at Cornell University. During the academic year of 1929-1930 he served as an Instructor in Biology at Oberlin College. In 1930 Mr. Husted was granted a du Pont Fellowship and that fall entered the University of Virginia to work for the Ph.D. degree. At the University of Virginia he also held a Blandy Farm Fellowship and was one of Dr. Orland Emil White's students at the Blandy Experimental Farm at Boyce, Virginia. The Ph.D. in Biology was awarded in 1934. Postdoctoral work on a General Education Board Fellowship was carried out at the University of Missouri during the session of 1934-35. Postdoctoral work was also done at the Bussey Institution at Harvard in 1935-36 and at the John Innes Horticultural Institution in 1936-37. During part of 1937 Mr. Husted also worked at the Institute of Animal Genetics, Edinburgh.

Mr. Husted was appointed Assistant Professor of Biology at the University of Virginia in 1937, Associate Professor of Biology in 1946 and since 1953 had served as Professor of Biology. It was at the University of Virginia that he became so well known for his teaching and research. His lectures in Introductory Biology were greatly enjoyed by those lucky enough to be assigned to his section. Through his teaching many were influenced to select biology as their major field of work. Advanced students and graduate students had the benefit of his training and skill as a teacher in courses in cytology, cytogenetics and heredity. It was in the classroom and laboratory that he was at his best. Here he challenged his students and aided them in learning the secrets of the cell and nucleus. A skilled microscopist and technician he was able to find and demonstrate facts which had escaped the search of many. Graduate students in other areas of biology found Mr. Husted always ready and willing to help them solve some problem with which they were faced in their research. As one of his last students writes, "Most of all I will remember him as a teacher. Dr. Husted was a man who could make his students learn and stimulate them to go beyond the immediate demands of the course material." As he himself wrote, "My vocation is my avocation."

Ladley Husted was active in many areas of the University. He served not only as secretary of the Department of Biology from 1946-1948, but as its Chairman from 1949 to 1957. In the College of

Arts and Sciences he served on numerous committees and represented the College in the University Senate. No committee did he enjoy more than the University Committee on Trees. As Chairman of this Committee, he was responsible for the care and replacement of specimen trees that beautify the Grounds of the University. He also took great pride in the Biology greenhouse for which he was largely responsible and in which he loved to work. Both the Virginia Chapter of Sigma Xi and the A.A.U.P. benefited by his presidency.

Ladley Husted's many publications were concerned almost exclusively with studies of chromosome structure and behavior. He was a fellow or member of numerous professional biological societies and organizations. He contributed his time and energy to the Virginia Academy of Science for many years, serving as a member of its Council for the 5-year period, 1949-54. It was his detailed report of the Academy in May 1949 as Chairman, the Virginia Journal of Science Committee, which played a major part in initiating the new series of the Journal.

He is survived by his wife, Kathryn Funkhouser Husted, his son, Robert Ladley Husted, and one grandson.

Dr. Ladley Husted was a true gentleman, a tireless worker, a keen observer, and a lover of life which he enjoyed to the fullest. He will be missed by a host of loyal friends and admirers.

B. F. D. RUNK

ALLAN BERNE-ALLEN 1902-1969

Allan Berne-Allen died April 15, 1969, in Sarasota, Florida where he has lived since 1956. From 1934 to 1947 he was with E. I. duPont de Nemours and Co. in Waynesboro, Virginia, in the research and development department and as a technical assistant in operations. During this period he was active in the Virginia Academy of Science and in the Virginia Section of the Chemical Society (Chairman, 1941). From 1942 to 1946 he was a Major in the Chemical Warfare Service, and was chief of chemical industries on General MacArthur's staff in Japan. In 1947 he became Professor of Mechanical Engineering at the University of California in Berkeley, and from 1948 to 1955, he was head of the Department of Chemical Engineering at Clemson Agricultural College.

Dr. Berne-Allen was born on Staten Island, N. Y., August 13, 1902. He was a graduate of the University of Michigan (B.S.E., 1924) and Columbia University (Ch.E., 1933; Ph.D., 1936).

From 1962 to 1966 he was a member of the Board of Directors of the Fats and Protein Research Foundation and a member of their research com-

mittee; he held numerous patents in this field. He was a Fellow of the American Institute of Chemists and a member of the American Association for the Advancement of Science, the American Oil Chemists Society, the American Chemical Society, the American Institute of Chemical Engineers, the

American Society of Engineering Education, the American Association of University Professors, and the Academies of Science of both Virginia and Florida. He was also a member of Sigma Xi, Phi Lambda Upsilon, Phi Kappa Phi and Phi Gamma Delta. He is survived by his wife, Helen K. Berne-Allen.

News and Notes

PROFESSOR BEAMS HONORED

Dr. Jesse W. Beams, who on June 30, 1969 retired as professor of physics at the University of Virginia and who last year received the National Medal of Science, was honored by a special symposium at the University of Virginia on May 24, 1969.

Distinguished scientists from throughout the United States, friends and former students of Dr. Beams heard talks on two fields to which he has made noted contributions: gravitation and ultracentrifugation.

Dr. Beams was cited for his work with high speed centrifuges when he was presented the National Medal of Science by former President Johnson at a special White House ceremony a year ago. Spinning more than one million times each second, centrifuges designed by Dr. Beams have been important tools to biological and medical science for protein and virus separations and to nuclear engineering for isotope separation.

During World War II, Dr. Beams worked with the Manhattan Project, which employed the centrifuge to successfully separate the uranium isotopes.

As director of a three-year National Aeronautics and Space Administration project at the University, Dr. Beams has been particularly interested in experiments testing gravitational theory. His team conducted experiments using two objects to measure gravitational forces with extremely high precision.

At the symposium honoring Dr. Beams, Dr. Richard H. Dicke, Cyrus Fogg Brackett Professor and chairman of the physics department at Princeton University, delivered an address on "Gravitation." Dr. Dicke is known for his experimental and observational tests of Einstein's general theory of relativity.

Dr. Howard K. Schachman, professor of molecular biology and biochemistry at the Virus Laboratory of the University of California at Berkeley, spoke on "Ultracentrifugation: Present and Future." An editor of several journals and former Guggenheim Fellow, Dr. Schachman works with macromolecules of biological interest, particularly proteins.

Dr. Beams received his Ph.D. from the University of Virginia in 1925 and joined the faculty in 1928. A former president of the American Physical Society, Dr. Beams has been Francis H. Smith Professor of Physics at the University since 1953. He was president of the Virginia Academy of Science, 1947-48 and recipient of its Meritorious Service Award in 1963. After his retirement he will continue research as a senior research scholar in the physics department.

The symposium was sponsored by the department of physics as part of the University of Virginia's 150th anniversary celebration.

AMERICAN ASTRONOMICAL SOCIETY

Dr. Laurence W. Fredrick, Professor and Chairman, Department of Astronomy of the University of Virginia and Director of its Leander McCormick Observatory has been elected Acting Secretary of the American Astronomical Society and its primary office is now located at the University in Charlottesville. This is the professional Society for astronomy in North America and has 2600 members.

DISTINGUISHED SERVICE AWARDS

Dr. Mary Eugenia Kapp, chairman of the Department of Chemistry of the Virginia Commonwealth University, Richmond, received the Distinguished Service Award of the Virginia Section of the American Chemical Society for 1969.

A native of Mount Airy, North Carolina, Dr. Kapp received the A. B. degree from the University of North Carolina at Greensboro, the master's degree from Duke University, and the Ph.D. degree from the University of North Carolina at Chapel Hill. Early in her career, she was instructor of chemistry at Sophie Newcomb College of Tulane University, and head of the Science Department at Blackstone College and at Averett College. In 1940, Dr. Kapp joined the staff of Richmond Professional Institute as assistant professor and head of the Department of Chemistry. During the war years, 1942-46, she worked as assistant chief chemist at E. I. duPont de Nemours and Company in Richmond. Upon her return to Richmond Professional Institute in 1946, she was promoted to associate professor. In 1952, she was appointed chairman of the School of Applied Science. In 1966, this school was reorganized and made a department, which Dr. Kapp chairs, within the School of Arts and Sciences of Virginia Commonwealth University.

Dr. Kapp first became associated with the American Chemical Society in 1937. She has served in many offices in the Virginia Section. She was chairman of the Virginia Section in 1952, the only woman ever to hold this office. She also is active in the Southeastern Regional meetings of the American Chemical Society.

Dr. Kapp has given generously of her time and talent to the cause of science in Virginia. She is an active member of the Virginia Academy of Science and has promoted the activities of the Virginia Junior Academy of Science in addition to working with the Westinghouse Science Talent Search and local science fairs. She recently has been appointed to the Advisory Committee of the Technical-Science High School for Chesterfield County, Virginia.

Presentation of the award was made by Dean J. Edwin Whitesell of the School of Arts and Sciences, Virginia Commonwealth University at the annual

awards meeting of the Virginia Section of the American Chemical Society in Richmond, June 6, 1969.

At the same meeting the Distinguished High School Teaching Service Award of the Virginia Section of the American Chemical Society for 1969 was presented to Miss Mary Virginia Carson, chairman of the Science Department, at the John Handley High School, Winchester.

Mary Virginia Carson was born in Frederick County, Virginia and received her elementary and secondary education in the public schools of Frederick County and the city of Winchester. She was graduated from the John Handley High School in June 1943. As a senior in high school, she was voted the "Best Student" in her class and was secretary-treasurer of the Library Club. She attended Madison College where she was awarded the Bachelor of Science degree in 1947. While in college she held membership in Sigma Pi Lambda (Junior Honorary Society), and Kappa Delta Pi (National Honorary Society).

Miss Carson began teaching the fifth grade at Handley School in the fall of 1947. Several years later she began teaching general science in the high school and for the past ten years has taught chemistry and physics.

The school recently received a certificate for having been chosen by the American Association of Physics Teachers for honorable mention among the high schools of the United States for excellence in the teaching of physics.

For several years Miss Carson has been the co-sponsor of the local Luther S. Hale Science Fair and the Handley Science Club. She is the sponsor of all student participation in science competitions. Since 1960, seventy-two students have received awards from the National Science Fair, the Shenandoah Valley Science Fair, National Science Foundation Summer Institutes, Virginia Junior Academy of Science, Ford Future Scientists of America, Youth Conference of the Atom, National Junior Science and Humanities Symposium, and the Virginia Science Talent Search.

Students and co-workers regard Miss Carson as a dedicated teacher. Her high sense of values, her integrity of character, her dedication to her job, her all-consuming interest in science, her loyalty to the school, administration and fellow faculty members represent the highest standards of the teaching profession.

Presentation of the award was made by Mr. Jacob L. Johnson, Superintendent of the Winchester City Public Schools.

BIOLOGY TEACHER HONORED

The Outstanding High School Biology Teacher Award in Virginia for 1969, was presented by the National Association of Biology Teachers to Edward Vance Parks of Tangier Island.

Mr. Parks received his B. S. degree from State Teachers College, now Longwood, and his MEd from the University of Virginia. A native of Tangier, Mr. Parks began teaching in 1946 at Tangier High School. He currently is teaching eighth grade general science, ninth grade general science, biology, eleventh and twelfth grade combined physics and Algebra II. In alternate years he teaches eleventh-twelfth grade combined chemistry.

Tangier High School with all its brightness, nestled on Tangier Island in the middle of Chesapeake Bay, has an environment completely marine. The island, the bay and the school have become the laboratory in which Mr. Parks and his students carry on their investigations.

Because of the abundance of marine life and the scarcity of flora, fauna, rocks and minerals, Vance, as he is known by his co-workers, started an exchange program between his school and other schools which have a different environment. Students are charged with the responsibility of carrying on the program. The students enjoy this phase of the program, for they gain new friends as well as learn about the environment of other areas and man and his relationship to his environment.

Because most of the students become watermen and since a growing American population is demanding more seafood, Vance's philosophy has become one of educating youth to produce more and better seafood as well as preparing those students who go on to college. Former students have pursued various fields including chemistry, biology and marine biology.

As the science teacher, Vance also serves as head of the Science Department and supervisor of Elementary Science. In addition, he has served as clerk for the Town of Tangier and director for the Chesapeake Island Electric Cooperative.

Vance may be seen after school hours along the water's edge collecting specimens along with his students, for education has become his life. When conditions do not permit working with students in the afternoon, he may be seen making necessary repairs around the school.

The award was presented at a Tangier High School assembly by Dr. George Jeffers, recently retired professor of biology at Longwood College.

VIRGINIA ACADEMY OF SCIENCE

FORTY-SEVENTH ANNUAL MEETING, FREDERICKSBURG

MAY 8-10, 1969

SUMMARY OF COUNCIL MEETINGS

Council met Thursday, May 8, 1969, President Siegel presiding and again on Saturday, May 11, 1969, President Carpenter presiding.

Mr. Carpenter presented a report of his activities as director of the Visiting Scientists Program. The treasurer's report was entered by President Siegel in the absence of Treasurer Maurice Rowe. The secretary reported that he has made an effort to expand the minutes of Council and the Executive Committee and to enlarge the distribution of copies of these minutes to all committee and section chairmen. A Council member suggested that copies should also be sent to section secretaries and the secretary agreed to do this in the future. Reports of various section representatives and standing committees were submitted and discussed.

SPACE SCIENCE AND TECHNOLOGY SECTION

The Space Science and Technology Section of the Virginia Academy of Science was organized in 1966. The following table summarizes pertinent information about the Section.

The Space Science and Technology Section, having held meetings with a successful technical program for the past 3 consecutive years, requested recognition as a permanent section of the Virginia Academy of Science.

After submitting his report, Mr. James P. Wightman moved approval of council that the Space Science and Technology Section be recognized as a permanent section of the Virginia Academy of Science. The motion was approved.

MUSEUM OF SCIENCE

Council authorized appropriation of \$1000 from general funds for the study of the establishment of a Museum of Science in Virginia; the Executive Committee was empowered to receive donations to supplement this fund; the manner in which it will be used was left to the discretion of the Executive Committee.

LOCAL ARRANGEMENTS FOR 1970

Addison Campbell discussed local arrangements for the 1970 meeting in Richmond. The Hotel John Marshall has been informed of space requirements and is providing good cooperation. The Marshall room has been cleared for use by the exhibitors. Mr. Campbell has met with Mr. Wisman and has worked out the details of the VJAS requirements.

President Carpenter requested President-elect Rowe to contact the president of VPI with regard to setting up a local arrangements committee for the following year.

Mr. Harlow reported that there was some interest in a dinner meeting of the Academy Assembly. Council supported the idea of a dinner meeting of the Assembly with details of the dinner arrangements left to the Executive Committee.

President Carpenter reported that sentiment was growing for the establishment of a Botany section in the Academy, and led a discussion on procedures for the establishment of a new section.

Mr. Wisman asked for comments about the presentation of the winning VJAS papers to the senior sections of the Academy. This elicited several fa-

Year	1966	1967	1968	1969
Section Officers				
Chairman	J. E. Duberg	J. E. Duberg	J. B. Eades	J. P. Wightman
Secretary	W. R. Beckett	W. R. Beckett	J. P. Wightman	J. K. Haviland
Editor	W. R. Beckett	W. R. Beckett	J. P. Wightman	R. N. Zapata
Councilor	J. B. Eades	J. B. Eades	J. B. Eades	J. P. Wightman
No. Papers Presented	18	18	21	23
Source of Papers (%)				
NASA	15%	35%	24%	
U. Va.	35%	35%	29%	
VPI	25%	18%	32%	
W & M	10%	12%	—	
Others	20%	—	20%	
No. Registering	52	53	60	

vorables comments, a general feeling that the quality had improved, and that the practice should be encouraged and continued.

REPORT OF MEMBERSHIP COMMITTEE

The number of active members of the Academy is now at an all time high—and an increase of nearly 50% since 1965. During the past year 332 new members were added to the rolls, bringing the total to date to 1776. This achievement is due in part to the hard work of my Committee, but also to the Officers of the Academy who have encouraged the attitude that all members of the Academy should consider themselves ex-officio members of the Membership Committee. This attitude has contributed greatly to the growth of the Academy. It is a pleasure to note that a considerable number of regular members have upgraded their membership to *contributing or sustaining*. It is obvious that the Academy's finances will be in much better condition if this trend continues. The chemists (largely academic) and biologists continue to have the largest percentages as members of the Academy—each with 20%. The medical scientists also can be singled out for their high percentage representation in the Academy—10%. The disciplines having great potential for expansion are the industrial engineers and chemists, and high school science teachers. Higher representation in the Academy of these two groups is greatly needed; and these groups would profit by greater participation in Academy affairs. Miss Virginia Ellett and Dr. Preston H. Leake of our Committee are to be commended for their excellent work with the teachers and industrial scientists respectively. At President Siegel's request, the Membership Committee undertook the task of laying the ground work for establishing a new category "Fellow of the Virginia Academy of Science."

Roscoe D. Hughes

REPORT OF THE BUSINESS ADVISORY COMMITTEE

Mr. Berry reported at the Council Meeting on March 29 that 30 of the 37 Business Members have paid their dues for 1969. Since that time, we have received one additional payment. Of the remaining unpaid members, one of the businesses has been sold and we do not anticipate a renewal. Over the year we have contacted a very large number of business concerns by letter but have had very little success in this approach. Several months ago some of the Academy members indicated that they would be willing to help us in our endeavor. We would like to request that if at all possible they follow through with their contacts. We have found that the only feasible method of approach in obtaining business membership is direct personal contact through our members of the Virginia Academy. We solicit the aid of any and all interested Academy members in obtaining business members. Mr. Rodney Berry

has been of great assistance and help in carrying out the responsibilities of this committee.

Richard M. Irby, Chairman
(Submitted by Paul Siegel)

REPORT OF THE SCIENCE TALENT SEARCH COMMITTEE

1968-69 was a very good year. Ninety-six teachers from 91 high schools requested examination materials from Science Clubs of America for the Westinghouse Science Talent Search. One hundred thirty-two entries from 48 high schools were accepted by Science Clubs of America. Nineteen students from 14 high schools were in the Virginia Honors group. Three students from 3 high schools were in the Virginia Winners group. Virginia is tied for 4th place with Ohio in the Honors Group, behind New York, Illinois and Pennsylvania. Virginia is tied for 5th place with Pennsylvania and Florida for winner behind New York, California, Illinois and Texas. This competition includes 50 states and the District of Columbia.

Forty-six students were invited to this Virginia Academy of Science meeting. Interviews were held today (8 May 1969) and thirty-eight students attended. Six students were attending the Science Fair in Texas and thus could not attend this meeting. The fifteen winners will be announced during the Awards Hour on Friday (May 9th).

Edgar V. Russell, Director

REPORT OF THE TRUSTEES

The Trustees have reviewed the investments of the trust fund account at First and Merchants National Bank and, as of February 27, 1969, the market value of the investments held was \$52,653. Annual income is estimated at approximately \$2250.

A suggestion as to changes in our holdings of common stock was made by the Bank and approved by the Trustees. The purpose of this change was to obtain a higher percentage of yield.

The investments are reviewed by the Trustees after each quarterly report.

Edward S. Harlow, Chairman

REPORT OF THE MUSEUM OF SCIENCE COMMITTEE

Mr. Harlow reported that an excellent program on the Science Museum in Virginia had been planned, distributed copies of the program and expressed the hope that a summary of the symposium proceedings would appear in the Journal. Mr. Carpenter reported that he had written the college presidents, calling their attention to the symposium and inviting them to attend.

REPORT OF THE AD HOC COMMITTEE ON EXECUTIVE OFFICES

Mr. Harlow also presented the report of the Ad Hoc Committee on Executive Offices for its chair-

man, Wilson Bell, who was absent. The full report appears in the minutes. Council voted approval.

REPORT OF THE VIRGINIA JUNIOR ACADEMY OF SCIENCE COMMITTEE

The annual meeting just concluded has culminated another successful year of the Virginia Junior Academy of Science. This has been accomplished in spite of a 34% decrease in the VJAS budget due mostly to a cut-back in the National Science Foundation grant. The total operating budget for the year was \$7200.

Even though only token financial assistance could be given to student participants attending the annual meeting this year, interest and participation of the schools, teachers and students has remained undaunted. The Committee feels this is real testimony to the value of the Academy in promoting science aptitude and training in the schools.

If anything, participation has increased. Although the number of school affiliations remained the same, 280 students submitted research papers for the Annual Meeting competition compared to 240 last year. Of these, 166 were selected for presentation. The total VJAS meetings registration this year, including students and teachers, was 800, compared to 430 last year, a marked increase!

VJAS activities for the year again included the publication of the *Proceedings* containing a full description of the 1968 annual meeting, the papers presented, the some seventy awards presented for student achievement, and the publication of the *Senior Science Bulletin*, a news-type medium for student members. Senior academy members should especially examine the 1969 *Proceedings* to be published in October for a complete account of the 1968-69 VJAS year.

Under new developments, the Committee wishes to acknowledge the Woman's Auxiliary to the Virginia Veterinary Medical Association for initiating the Virginia Veterinary Auxiliary student award carrying a \$50.00 cash prize. The interest and support of adult scientific societies and organizations is vital to the junior academy effort.

The Committee wishes to express its deep appreciation to the officers and members of the senior academy for their continued strong support. Without it the Virginia Junior Academy of Science would be unable to retain its reputation as perhaps the best Junior Academy in the nation.

E. L. Wisman, Chairman
(Submitted by Paul Siegel)

REPORT OF THE LONG RANGE PLANNING COMMITTEE

During the past year, the Long Range Planning Committee has met twice: in Charlottesville on 14 October, and in Richmond on 13 April.

Discussion during the first meeting centered on the duties and responsibilities of the Committee, and what course should be followed to avoid getting in-

volved in "brush fire" considerations. One of the prime areas of interest to the Committee, arising from the discussion, is the responsibility of the Academy to both the beginning student of science and his teacher, and what the Academy might do to aid in the development of science programs at the elementary and high school levels throughout the state.

The second meeting continued the discussions concerning the "junior scientist" and his teacher, and also started a probe to find a manner for properly selecting meeting sites for the annual Academy meeting.

Subcommittees to deal with these propositions were formed, respectively Goldstein, Ulrich, Mrs. Thaxton and ex-officio Stevenson; and Clarke, Jeffers, Sears and Lowry. Reports of these subcommittees will be made to Council at the Fall Council Meeting.

The problem of continuity in both the Committee and other committees was discussed.

No specific recommendations are made at this time.

A. M. Clarke, Chairman

REPORT OF THE RESEARCH COMMITTEE

On October 22, 1968, letters were addressed to the presidents of all colleges and universities in Virginia requesting that they encourage the members of their science faculties to participate in the J. Shelton Horsley Award competition. At about the same time, arrangements were made with the president of the University of Florida Chapter of the Sigma Xi to evaluate the papers submitted. Twenty papers were offered in the competition—eight in the field of Biology, six in Chemistry, three in Statistics, two in Engineering, and one in Astronomy.

Five requests for research support were received during the year, and four of them were granted:

- (1) Mitchell A. Byrd, William and Mary—Studies of the breeding ecology of colonial birds on the Eastern Shore \$300.00
- (2) A. M. Harvill, Longwood College—Travel expenses of authors of *The Virginia Flora*, to study plant collections at herbaria \$500.00
- (3) Harold G. Marshall, Old Dominion College—Study of phytoplankton populations in the Lower Chesapeake Bay and the James River estuary system \$296.00
- (4) W. L. Mengelbier, Bridgewater College—Effects of invertebrate hormones on succin-oxidase and cytochrome oxidase activity on rat tissues \$249.50

Horton H. Hobbs, Jr., Chairman

REPORT OF THE PUBLICATIONS COMMITTEE

Dr. Herbert McKennis, Jr., resigned as Editor of the Virginia Journal of Science in midsummer of 1968. The Committee recommended the appointment of Dr. Lynn D. Abbott, Jr., as Editor, and the

recommendation was approved by the Executive Committee. Dr. Abbott assumed his new duties with the Volume 19, No. 4 issue of the Journal.

Some progress has been made in connection with the manuscripts on the Dismal Swamp. Three articles (on (1) Forests, (2) Geology and (3) Birds) have been retrieved and turned over to the Journal Editor. A fourth, on Soils, is being revised and is promised soon. A fifth, on Mammals, is also in process of revision.

Revision on the last three chapters of the Academy History has progressed more slowly than anticipated. Preliminary planning with the Flora Committee has brought consideration of publication of a manual dealing with the Virginia flora. The abstract form for reproduction by offset process worked out with Dr. McKennis was successfully used in the 1968 Proceedings issue of the Journal (Volume 19, No. 3).

Walter S. Flory, Chairman

REPORT OF THE FINANCE COMMITTEE

President Siegel noted that the report of the Finance Committee had been received and referred to the detailed discussion of that report by Council as reported in the minutes of the March 29, 1969 meeting.

REPORT OF THE FLORA COMMITTEE

The most important action of the year was forming an organization of botanists at the fall meeting to revise the vascular plant groups and publish a flora of Virginia. More than 50% of these groups are allocated to the following:

Gymnospermae	Peter Mazzeo, National Arboretum, Washington
Peridophyta	C. E. Stevens, Charlottesville
Cyperaceae+	A. M. Harvill, Longwood College
Orchidaceae	William Hooks, Lynchburg College
Polygonaceae	Richard Mitchell, Virginia Polytechnic Institute
Ranunculaceae+	Gwynn Ramsey, Lynchburg College
Violaceae	Jack Brooks, College of William and Mary
Acanthaceae+	Leonard Uttal, Virginia Polytechnic Institute
Compositae	Gustav Hall, College of William and Mary
Compositae	Miles Johnson, Virginia Commonwealth University

Field workers were active during the year adding more than 10,000 specimens to Virginia herbaria. Some thirty individuals located throughout the State are associated with us in this work. A number of out-of-state botanists are reviewing groups and aiding the project in many technical areas.

Gustav Hall organized the new herbarium at William and Mary and Richard Mitchell saw the Massey

Herbarium housed in new facilities at the Virginia Polytechnic Institute.

Leonard Morrow collected extensively in the Henrico Co. area, organized field courses, published a paper, and did spade work on the flora projects.

Gwynn Ramsey participated in the Smithsonian Plant Systematics Institute, collected 1500 plants for the Lynchburg Herbarium, added another 2000 from associates, and published a paper.

Mrs. Vera Remsburg worked with high school groups and organized a field trip for the May meetings.

The chairman published two papers, wrote two articles for our Newsletter, and with his associates, added 4000 Virginia specimens to the Longwood Herbarium.

A. M. Harvill, Jr., Chairman

AD HOC COMMITTEE FOR RESTRUCTURING THE LIFE SCIENCE SECTIONS

The committee is presently polling the membership for suggestions and holding periodic discussions to draft a proposal for restructuring the Life Science Sections. This proposal is not yet ready for presentation to Council.

Charles E. Hamner, Chairman

REPORT OF THE VISITING SCIENTISTS PROGRAM

In May 1968 President Siegel asked the President-Elect to be responsible for this program by finding a director or by assuming these duties himself. President-Elect Carpenter assumed this responsibility utilizing his departmental secretary who was paid a modest fee by the Academy for the clerical work and typing involved. The Academy also furnished funds for postage and paper.

In August the Superintendent of Public Instruction gave his permission for the program to be operated in the public schools and announced this by a memorandum to division superintendents. The director requested by letter to these superintendents the names of high school personnel to whom speakers lists should be sent. Private schools were also included in this mailing.

Also in August, 42 college presidents agreed to support the program by providing travel expenses for any of their faculty who volunteered to speak. Certain additional persons not related to a college who had volunteered previously were also contacted. 237 speakers from 20 colleges volunteered and provided topics on which they would speak.

A speakers list was assembled in mid-October containing many names of speakers from 1967-68, new names, and new or updated topics. This list was distributed in late October to over 400 persons with the request that the director be notified in writing by the high school or private school when a visit was made including who spoke, to whom, when, where and to how many.

In mid-May a follow up letter will be sent to the 237 speakers requesting the above information to

assist in obtaining accurate statistics. As of 1 May 1969, over two dozen visits had been reported but it is felt this number is far short of an accurate count due to the laxness in reporting by school personnel.

A summary of the speakers list by institution and subject follows.

Institution	Speaker Volunteers
Bridgewater College	11
Emory and Henry College	6
Hampden-Sydney College	6
Hollins College	2
Longwood College	2
Lynchburg College	14
Madison College	3
Mary Washington College	7
Old Dominion College	4
Radford College	2
Randolph-Macon College	11
Randolph-Macon Woman's College	3
Roanoke College	4
Sweet Briar College	4
University of Virginia	24
Virginia Commonwealth University	6
Virginia Military Institute	11
Virginia Polytechnic Institute	86
Washington and Lee University	20
College of William and Mary	10
State Board of Education	1
<hr/>	
Topics	237

Topics	Speaker Volunteers
Astronomy	4
Biology	32
Chemistry	30
Economics	2
Engineering and Applied Science	7
Geological Sciences	13
Mathematics	20
Medicine	1
Physics	47
Physiology	1
Psychology	11
Sociology	6
Statistics	5
VPI—Agriculture and Engineering	58
<hr/>	
D. Rae Carpenter, Jr. Director	237

SUMMARY OF THE ACADEMY CONFERENCE

The Academy Conference convened on Friday, May 9, 1969 in Combs Science Hall, Mary Washington College, Fredericksburg, Virginia, President Paul Siegel presiding. One hundred and seven were counted in attendance.

Secretary Turner read the proposed constitutional

change establishing the Fellow as a new class of membership as reported in the Winter edition (1969) of the Virginia Journal of Science, Volume 20, No. 1, p. 26 and moved adoption. The motion was seconded and discussed extensively. Of 80 members voting, the tally was 67 "for" and 13 "against." President Siegel ruled the motion carried.

The reports of the Academy Sections, the Standing Committees and the Special Committees were read by the secretary. These reports are included as part of the minutes of the Council meeting of May 8, 1969.

Mr. Hughes, reporting for the Nominating Committee, entered the following officers into nomination for the year 1969–70:

President-Elect: Maurice B. Rowe

Secretary: Edward F. Turner, Jr.

Treasurer: Austin Grigg

No other nominations were forthcoming and the above were elected officers of the Academy for the coming year.

SUMMARY OF THE ACADEMY ASSEMBLY

The Virginia Academy of Science Assembly convened in the George Washington Auditorium, Mary Washington College, Fredericksburg, Virginia on Friday evening, May 9, 1969, President Paul Siegel presiding.

Chancellor Simpson gave a warm welcome to the assembly in brief remarks.

Mary Kapp presented the report of the Resolutions Committee.

Franklin F. Flint presented the J. Shelton Horsley Research Award to Drs. A. J. McCaffery, Paul N. Schatz, and T. E. Lester for their joint paper, "Magnetic Circular Dichroism of IrCl_6^{2-} in Crystalline $(\text{CH}_3\text{NH}_3)_2\text{SnCl}_6$." Dr. Schatz received the award on behalf of the co-authors of the paper.

Lynn D. Abbott presented the Ivey F. Lewis Distinguished Service Award to Walter S. Flory in recognition of his distinguished service to the Academy.

Members in attendance were then treated to a delightful film by William J. L. Sladen, made by him and others as part of their research on "The Adult and Juvenile Behavior of the Adelie Penguin." Professor Sladen gave a running commentary on the film. The film and commentary constituted the Sidney S. Negus Memorial Lecture for the annual assembly and was warmly received.

The new officers of the Academy were introduced as follows:

President: Rae Carpenter

President-Elect: Maurice Rowe

Secretary: Edward F. Turner, Jr.

Treasurer: Austin Grigg

President Siegel then relinquished the gavel to incoming President Carpenter, who concluded the assembly with a few remarks.

IVEY F. LEWIS DISTINGUISHED SERVICE AWARD

The Virginia Academy of Science is privileged to present to Professor Walter S. Flory, Jr. the Ivey F. Lewis Distinguished Service Award for 1969.

This award, the highest award bestowed by the Virginia Academy of Science, is presented for significant contributions toward the activities of the Virginia Academy of Science. This year's recipient is an international leader in the field of biology and genetics and has participated enthusiastically in almost every area of the activities of the Virginia Academy of Science.

He has held the following positions with the Academy: President, 1955-56; Chairman of the Research Committee, 1951-54, committee member, 1949-54; Flora Committee, 1949-63; Member of the Council, 1952-62, 65-68, 68-present; Chairman of Long Range Planning Committee 1960-62; member Natural Resources Committee, 1962-63; Chairman Biology Section, 1962-63; Chairman of the Publications Committee, 1964-present. He was the recipient of the Academy's J. Shelton Horsley Research Award in 1949. There is possibly no one who has devoted more of his time to encouragement of the programs of the Academy. Although he no longer resides in Virginia, he has continued to exert the same energy, and with the same success, as he did when living here.

His work at the Blandy Experimental Farm, as well as other previous positions, has attracted national and international recognition. When one looks at his work at Bridgewater College, Harvard, Texas

A&M University, Virginia Polytechnic Institute, the University of Virginia, and Wake Forest University, one is amazed at the stature of his programs and their accomplishments. He is listed in all biographical directories and has been included in Who's Who in America since 1948, and in World's Who's Who in Science, 1968.

He is a member of some 20 national and international scientific societies, and is a member of: Sigma Xi, Phi Sigma, and Phi Beta Kappa. He has published widely.

Dr. Flory currently holds the Babcock Professorship of Botany and is Director of Reynolda Gardens, Wake Forest University in Winston-Salem, North Carolina.

REPORT OF THE TREASURER

The financial records of the Executive Secretary-Treasurer, for the year 1968, have been audited by J. Waddell Rison and Co., Certified Public Accountants, and found to be in good order. Copies of this audit have been given to the Academy Officers and to the Chairman of Finance and Endowment Committee. The Council requires that all academy funds be channeled through this office and both the Treasurer and the Executive Secretary-Treasurer are bonded.

The Treasurer's report to Council for the first quarter of 1969 showed continued improvement in the payment of dues and an increase in the membership.

Maurice B. Rowe, Treasurer

GENERAL FUND:

Cash on hand, checking account 1-1-68	\$ 5,868.22
Receipts 1-1-68—12-31-68	<u>34,570.83</u>
	\$40,439.05
Disbursements, 1-1-68—12-31-68	<u>35,894.27</u>
Cash Balance, checking account 12-31-68	\$ 4,544.78
Invested at interest, available on notice	
Savings account 4%	\$ 8,000.00
Bank Savings Certificates 5%	<u>14,500.00</u>
	\$22,500.00
S. S. Negus Lecture Fund	\$ 2,500.00
Guy W. Horsley Fund	820.00
Due Va. Journal Fund	6,418.08
Subscriptions paid in advance	290.00
Members Dues and Gifts paid in advance	<u>10,154.50</u>
Encumbered	\$20,182.58
Investments unencumbered	<u>2,317.42</u>
Balance 12-31-68, Cash and unencumbered investment	\$ 6,862.20
(No unpaid obligations for 1968)	

Abstracts of Papers

Section of Agricultural Science

Forty-Seventh Annual Meeting of The Virginia Academy of Science
May 8-10, 1969, Fredericksburg, Virginia

THE RELATIONSHIP OF ROW SPACING, POPULATION, MATURITY AND HYBRID ON CORN PRODUCTION IN SOUTHEASTERN VIRGINIA.
M. W. Alexander and C. F. Genter, Tidewater Res. Station,
Holland, Va. 23391 and Dept. of Agronomy, Va. Polytechnic
Inst., Blacksburg, Va. 24061.

Three row spacings, 24", 30", and 36", along with 3 rates of planting, 18M, 24M, and 30M plants per acre, were planted to hybrids maturing early, intermediate and full season.

Hybrids within a maturity group showed differential yield response due to both variation in population and row spacing. Certain varieties showed more response to the population variable than in the row spacing variable. Percent barren stalks increased as the population increased. A higher percent barren stalks was noted for the full season hybrids in both 1967 & 1968. The percent erect corn was higher at the 18M population with no significant differences noted due to row spacing either in 1967 or 1968. Ear height was a few inches higher at 30M population in 1967.

CONTROL OF PEACH TREE BORERS IN VIRGINIA. Marvin L. Bobb,
Piedmont Res. Lab., Va. Polytechnic Inst., Charlottesville,
Va. 22901.

Two species of borers are injurious to peach trees in Virginia. The peach tree borer, *Samoniodes exitiosa* (Say), feeds only in the tree trunk at and below the soil level, but the lesser peach tree borer, *Synanthedon pictipes* (G. & R.), is usually found feeding in the cambium tissues of the larger limbs, although they may be found feeding in the tree trunk above ground.

A large number of insecticides have been tested in randomized field plots for control of these borers during the past several years, but relatively few have been effective. Endosulfan, parathion, Gardon® and Matacil® were the most effective of the insecticides tested. Sprays of endosulfan gave a slightly higher degree of control each year than any of the other materials. DDT gave good control of the peach tree borer but was ineffective on the lesser peach tree borer.

Timing of spray applications was extremely important. Observations indicated that the two species of borers were adequately controlled with four applications per season of endosulfan applied to the tree trunks and lower limbs at the following times (\pm 5 days): May 1, June 1, July 15 and August 15.

COMB LOCI AND MATING BEHAVIOR IN CHICKENS. W. T. Cook*
and P. B. Siegel. Dept. Poultry Science, Va. Polytechnic
Inst., Blacksburg, Va. 24061

The influence of bidirectional selection for cumulative numbers of completed matings (CNCM) on the frequency of alleles at the rose and pea loci, was studied. Data were from the F₀ and F₁ generations of the high mating (HML), low mating (LML), and control lines. Selection for increased CNCM resulted in a concomitant increase in the frequency of the R allele and decrease in the frequency of the P allele. The frequency of these alleles was not, however, different from that of the control line in the F₁ generation. The frequency of the R allele was very low in the LML in the F₀ generation and it was zero in the F₁ generation. In contrast, the frequency of the P allele in the LML was three times that of the control line. Three hypotheses are suggested to explain the changes in gene frequencies at the rose and pea loci. These are (a) one major gene block is acted upon in opposing directions; (b) two gene blocks operate, one each for the promotion of high and low CNCM; and (c) linkage and recombination.

FIELD OBSERVATIONS OF SOILS DEVELOPED IN UNCONSOLIDATED SEDIMENTS IN WESTERN SPOTSYLVANIA COUNTY, VA. J.H. Elder,
D. E. Pettry. Dept. of Agronomy, Va. Polytechnic Inst.
Blacksburg, Va. 24061

Broad, gently sloping ridges dominate the western part of the county. These ridges range in elevation from 350 to 450 ft. and slope eastward. The North Anna river forms the southern county boundary, and the Rapidan and Rappahannock rivers mark the northern boundary. Alluvial soils are very limited.

Mica-schists underlie the area, comprised largely of mica schist and gneiss with some igneous intrusions of Triassic dikes. Depth of weathering in the schist and gneiss ranges from 3 to more than 40 feet.

Sediments cover the schist and gneiss on the broad ridges and range from 1 to 6 ft. thick. Rounded quartzite fragments comprise 2 to 15% of the soil mass. Soils developed in the mantle are deep and have a high clay and silt content but low sand content. Visible mica fragments are rare. In places, stone lines mark the transition from sediments to residual soil materials.

Residual soils from schists and gneiss are thin with a 20-40 inch solon and also have a high clay and silt content. Few coarse fragments of vein quartz are in the subsoil.

Apparently, sediments uniformly covered the area as a broad flat plain. Later, down-cutting exposed the underlying schists where soils developed on side slopes and saddle positions. Soils in the overlying sediments are generally good for agriculture. However, residual soils developed from the schist and gneisses are marginal land.

RESPONSE OF VIRGINIA TYPE PEANUTS TO NITROGEN. D. L. Hallock, Tidewater Res. Station, Va. Polytechnic Inst., Holland, Va. 23391.

Farmers' reports in 1964 and 1965 noted peanut yield response to nitrogen fertilization. In 1966, a small demonstration test on a Woodstown loamy fine sand showed a yield response of about 500 lb/a to 60 lb/a of N as NaNO_3 applied in mid-July.

Replicated rates of 0, 50, 100, 150 and 200 lb/a of $\text{N}(\text{NaNO}_3)$ were applied on peanuts about mid-July, 1967. A significant (5% level) yield depression was obtained from application of N on another Woodstown loamy fine sand. No significant (5% level) yield or seed size response was obtained to N on Dunbar, Klej, and Norfolk loamy fine sands, or Bertie fine sandy loam soils. Also, in 1968, 75 lb/a N (NaNO_3) significantly (5% level) reduced both peanut yield and seed size. A 150-lb rate decreased these factors significantly (5% level) more than the 75-lb rate.

These results indicate that a general recommendation of supplemental N on peanuts is not warranted at present.

MAXIMUM CROP YIELDS ON CERTAIN VIRGINIA SOILS. S. D. Jones and J. A. Lutz, Jr., Dept. of Agronomy, Va. Polytechnic Inst., Blacksburg, Va. 24061.

Experiments to measure the maximum yields of alfalfa, corn, and red clover on some of the most important soils in Virginia have been in progress for seven years.

Five levels of N, P, and K were applied to corn on Groseclose, Davidson, Congaree, and Cecil soils. Five levels of N and K were applied to corn on Frederick soil. Five rates of P and K were applied to alfalfa on Groseclose, Frederick, and Davidson soil. Seven sources of P were applied at two rates for red clover on Groseclose soil.

Maximum corn silage and grain yields on Groseclose were 16 tons (65% moisture) and 107 bushels (15.5% moisture) per acre. Highest corn silage and grain yields on Davidson, without and with irrigation, were 22.4 and 31.5 tons and 171 and 212 bushels per acre. Maximum corn silage and grain yields on Frederick soil from high grade limestone were 27.8 tons and 181 bushels per acre. Frederick soil from low grade limestone yielded a maximum of 23.7 tons and 138 bushels per acre. Highest corn yields on Cecil soil were 25.1 tons and 142 bushels per acre with irrigation. On Congaree loam, highest corn yields were 31.1 tons and 207 bushels per acre. Highest alfalfa yields (12% moisture) on Groseclose and Frederick soils were 7.11 and 5.52 tons per acre. Maximum alfalfa yields without and with irrigation on Davidson were 6.64 and 7.82 tons per acre. Maximum red clover yields were 6.64 tons per acre.

CORN VARIETIES FOR NO-TILLAGE PLANTING. G. D. Jones, W. W. Moschler, and G. M. Shear*, Depts. of Agronomy and Plant Pathology and Physiology, Va. Polytechnic Inst., Blacksburg, Va. 24061.

Eighteen corn varieties were grown without tillage in 1968 to determine their suitability for no-tillage production. Yield differences were not statistically significant, but standability and maturity characteristics were. In standability the varieties fell into 3 groups in which there were no significant differences within a group, but the groups differed significantly from each other. The individual varieties ranged from 8.1 to 77.4% of erect stalks at harvest. It appears probable that this characteristic will be very important in selecting varieties for no-tillage. Despite the use of only "early" varieties, considerable variation in grain moisture content occurred at a single harvest date. Individually the varieties ranged from 17.6 to 24.8% of ear moisture. Four statistically significant groups were recognized.

EVALUATION OF NEW ANTIBIOTIC COMBINATIONS FOR GROWING PIGS. E. T. Kornegay, Dept. of Animal Science, Va. Poly. Inst., Blacksburg, Va. 24061 and Rutgers Univ., New Brunswick, N. J. 08903.

Three trials using 148 early weaned pigs were conducted to study the effectiveness of feeding different combinations, sources and levels of chlortetracycline, oxytetracycline, penicillin, neomycin, sulfamethazine, sulfaethiazole, sulfamerazine and phthalysulfacetamide in promoting improved gains and feed efficiencies. All antibiotic treatments appeared equally effective in significantly improving average daily gains. The improved gains seemed to be due to increased feed consumption of pigs fed rations containing antibiotics as the over-all feed efficiencies were not improved. There was an improvement in feed efficiencies in the early part of the trials, but this improvement was lost during the later part of the trials. In trial III, there was no significant advantage of feeding five times the recommended level of chlortetracycline, penicillin and sulfaethiazole. It appears from these studies that the addition of antibiotics to starter rations is beneficial in getting pigs off to a good start. (Aided by NOPCO Grant)

INSTRUMENTATION FOR INSECT OLFACTORY RESEARCH. G. A. Kranzler† U. F. Earp, J. M. Stanley*. Agric. Engr. Dept., Va. Polytechnic Inst., Blacksburg, Va. 24061.

A laboratory is being developed for research on insect olfactory attractants. Response to synthesized sex pheromone by the cabbage looper moth (*Trichoplusia ni*) is being assayed using electrophysiological techniques. An air carrier system has been designed to transport the olfactory stimulus to the moth receptor site for exposures of variable duration and interval. Instrumentation has been provided to detect receptor nerve potentials and produce recordings of the stimulus-induced signal oscillations resulting from exposure to the pheromone.

EFFECT OF NITROGEN SOURCE AND NITRATE LEVEL ON VITAMIN A METABOLISM. R. E. Lichtenwalner*, J. P. Fontenot and R. E. Tucker*, Depts. An.Sci. and B&N, V.P.I., Blacksburg, Va.

An experiment with a 3x2 factorial design was conducted with 30 individually fed fattening beef calves. Six rations containing similar levels of crude protein, TDN and carotene were fed. The nitrogen supplements were urea for rations 1 and 2, corn gluten meal for rations 3 and 4, and soybean meal for rations 5 and 6. Potassium nitrate (KNO_3) was included at the level of 1% in rations 2, 4 and 6. The cattle fed the ration containing the combination of urea and KNO_3 gained 0.2 kg. less ($P<.01$) and consumed 0.5 kg. less feed per day ($P<.01$) than those fed the other rations. Feed efficiency followed a similar pattern ($P<.01$). There were no other substantial differences in feedlot performance. Ruminal ammonia values were highest ($P<.01$) for the cattle fed the rations containing urea and lowest ($P<.01$) for those fed the rations containing corn gluten meal. Ruminal fluid pH values were highest ($P<.05$) for the urea-fed cattle and lowest ($P<.05$) for those fed corn gluten meal 1, 2 and 4 mo. after the beginning of the trial; there were no significant differences at the end of the trial (6 mo.). Liver vitamin A depletion was rapid in all cattle and was not significantly affected by nitrogen source or nitrate level. Plasma vitamin A levels of the cattle fed KNO_3 were lower after 1 mo. ($P<.10$) and at the end of the trial ($P<.05$), compared to cattle not fed KNO_3 .

NITROGEN METABOLISM BY LAMBS FED UREA OR SOY PROTEIN AS THE SOLE NITROGEN SOURCE. R. L. Ludwick*, J. P. Fontenot and R. E. Tucker*, Depts. An.Sci. and B&N, V.P.I., Blacksburg, Va.

Two metabolism experiments were conducted with lambs fed two purified rations containing approximately 8% crude protein. One ration contained urea and the other, soy protein as the sole nitrogen source. In experiment 1, eight lambs were allotted to the two rations. A 10-day preliminary period was followed by five successive 10-day collection periods. In experiment 2, 14 wether lambs were allotted to the two rations. A daily nitrogen balance study was conducted during the 10-day preliminary period, followed by eight successive 10-day collection periods. In both experiments, at the end of each collection period jugular blood samples were analyzed for urea and ammonia, and strained rumen ingesta samples were analyzed for volatile fatty acids and total, protein, nonprotein and ammonia nitrogen. Average cellulose digestibility tended to be lower for the urea-fed lambs during the early part of both experiments, but the differences were not significant. Urinary nitrogen excretion was higher ($P < .05$) and nitrogen retention was lower ($P < .05$) for the urea-fed lambs only for the first part of each experiment, indicating adaptation to urea feeding. Ruminal pH and ammonia N and blood urea were significantly higher for the urea-fed lambs; differences in blood urea levels decreased with time. In experiment 1 ruminal levels of butyric acid were less ($P < .05$) and levels of propionic acid were greater ($P < .05$) for the urea-fed animals.

CONDITION SCORE AT WEANING AND SUBSEQUENT GROWTH RATE OF OFFSPRING. T. J. Marlowe and G. L. Zahab*, Dept. of Animal Science, Va. Polytechnic Inst., Blacksburg, Va. 24061.

Replacement females were scored for fatness (1 to 5) at weaning and preweaning ADG calculated on 274 Angus in 27 herds and 174 Herefords in 15 herds which produced one or more offspring. Dams were grouped within breeds by weaning condition score and related to offspring preweaning ADG in a one-way ANOVA for unequal numbers. There were 438 and 285 offspring records for Angus and Hereford dams, respectively. Offspring records were limited to 2/dam. Unadjusted ADG of dams by condition with no. of obs. in parenthesis were (2) 0.440, (27) 0.694, (154) 0.730, (84) 0.762 and (70) 0.731 for Angus and (2) 0.663, (27) 0.6768, (95) 0.757, (49) 0.798 and (1) 0.967 kg. for Herefords. Corresponding adj. ADG of offspring were (20) 0.830, (42) 0.817, (250) 0.767, (137) 0.771 and (70) 0.671 for Angus and (2) 0.735, (29) 0.708, (89) 0.712, (63) 0.717 and (1) 0.849 for Herefords. The dams' ADG increased with condition score ($P < .01$) in both breeds. There were no significant differences in ADG of offspring. A regression analysis procedure failed to show any differences between dam and progeny ADG within or between condition scores of Herefords. Angus showed a highly significant ($P < .01$) difference between regression values of condition scores 3 and 4 when offspring adj. ADG was regressed on dam's ADG. If there is a true detrimental effect of fatness on development of secretory tissue in young females, the numbers were too small to demonstrate this effect with the exception of differences between condition scores 3 and 4 of Angus.

FECONDITY OF HETEROPTERA TABACUM ON FORTY TWO LINES OR VARIETIES OF NICOTIANA TABACUM. L. J. Miller* and P. L. Duke*, Res. Div., Va. Polytechnic Inst., Tidewater Res. Station, Hollins, Va. 23391.

An isolate of the tobacco cyst nematode from Hazardville, Connecticut was tested to determine its ability to develop egg-bearing females on 42 lines or varieties of tobacco. One hundred cysts containing 110-189 eggs/cyst were introduced into cyst-free soil in 4-inch pots containing two month old seedling was transplanted to each pot and grown at air temperatures of 23-27°C. After 5 weeks the soil was screened for females. Reproduction of the nematode was poor (0-3 females/plant) on B37, 304-1, PD7, NC2514, and NC1626-53C. A few females (4-20/plant) were found on Speight(SP) G41, Coker(C)319, and NC3909. A medium number of females (21-79/plant) were found on SP67, SPC27, SPC36, McNair(MN) 3322, NC2326, NC95, and VA3149. Numerous females (>80/plant) were found on PD335, PDS, PD511, PD28, SPC29, SPC13, McN561, McN4691, McN4194, McN20, McN5321, NC5505, NC3503C, VA2176, VA3160, VA2552, VA115, C65188M, C6232324S, C65254M, C298, C258M, C2135, Bel193, Hickey (Greensboro), L.S. Orinoco, B37 and 304-1 are burley lines, L.S. Orinoco a sun-cured variety, and the other entries are flue-cured lines or varieties.

EFFECT OF DAM'S SEASON OF BIRTH ON PREWEANING PERFORMANCE OF PREGNANT. T. J. Marlowe and C. E. Thompson*, Dept. of Animal Science, Va. Poly. Inst., Blacksburg, Va. 24061.

Preweaning performance records on 463 heifer calves saved for herd replacements in 8 Virginia Angus herds and their 926 offspring were compared to determine the effect of season of birth of the dams on the preweaning performance of their offspring. Dams were classified in a calf crop year as fall born (Aug - Nov) or spring born (Feb - May). Data included were limited to herds with at least 3 herd replacements born in each of the 2 seasons, each of which produced two calves. The two groups of dams were compared, within year and herd, on their own preweaning average daily gain (ADG) and the adjusted ADG of their progeny. Mean preweaning ADG of fall and spring born dams were 0.644 and 0.729 kg., respectively ($P < .01$). For the offspring, mean adjusted ADG were 0.754 and 0.753 kg., respectively, for the two groups of dams. Regressions of offspring adjusted ADG on dams actual ADG was only -.016. This study failed to support the hypothesis that more rapid preweaning growth rate of heifers with presumed greater fat deposition, results in lowered subsequent maternal performance. However, the data studied did not include extreme levels of ADG in the dams.

PHYSIOLOGIC VARIATION OF FIVE ISOLATES OF THE SOYBEAN CYST NEMATODE. L. J. Miller, Res. Div., Va. Polytechnic Inst., Tidewater Res. Station, Hollins, Va. 23391.

Each of the 5 isolates (Va.3, Va.4, Mo.1, Miss.1, and Ky.1) of *Heterodera glycines* tested proved to be distinct race which can be differentiated by its ability to develop egg-bearing females on different plants. *Glycine max*, 'Kilmer', *P. vulgaris*, 'Bountiful', *Glycine ussurriensis*, and *Vicia villosa* 'Madison'. Seventy sets (190-257 eggs/cyst) were introduced into methyl bromide-fumigated Ruston loamy fine sand soil in 4-inch pots. Single seed were planted of *P. aureus*, *P. vulgaris* and *G. ussurriensis* or 3 one-month-old seedlings of *V. villosa* were transplanted to each pot and grown at air temperatures of 23-27°C. Each treatment was replicated four times. After 5 weeks the soil was screened for females. Mo.1 and Miss.1 formed 14-30 females on *V. villosa*, the other isolates 0-1. Mo.1 formed 16-25 females on *P. aureus*, Miss.1 and the other isolates 2-4. Va. 3 and Va.4 formed 110-170 females on *P. vulgaris*, Ky.1 formed 21-34, and Mo.1 and Miss.1 isolates 1-8. Va.3, Mo.1, and Miss.1 formed 71-120 females on *G. ussurriensis*. Va.4 formed 42-54, and Ky.1 only 2-7.

RELATIVE EFFECTS OF DIFFERENT SUPPLEMENTAL MAGNESIUM SOURCES ON APPARENT DIGESTIBILITY IN STEERS. W. F. Moore*, J. P. Fontenot and R. E. Tucker*, Depts. An.Sci. and B&N, V.P.I., Blacksburg, Virginia.

Six beef cattle were used in a series of three metabolism trials to determine the relative effects of supplementation with magnesium oxide, magnesium carbonate and dolomitic limestone when fed to supply approximately 900 mg magnesium per day. Each trial consisted of a 10-day preliminary period followed by a 10-day collection period. Blood and rumen ingesta samples were obtained prior to the beginning and at the end of each trial. The apparent digestion coefficients for dry matter, crude fiber, NDF and energy were lower ($P < .05$) for the ration supplemented with dolomitic limestone than for the other two rations, and there were no significant differences between the rations containing magnesium oxide and magnesium carbonate. For example, the digestion coefficients for crude fiber were 55.4, 65.2 and 65.1% for the rations supplemented with dolomitic limestone, magnesium oxide and magnesium carbonate, respectively. The 57% excretion time (rate of passage of the digesta through the omasum, abomasum and intestines) was faster ($P < .05$) for the ration supplemented with dolomitic limestone than for the other two rations. Magnesium absorption was lower ($P < .05$) for dolomitic limestone than for the magnesium oxide. The results indicate that some factor other than magnesium carbonate in the dolomitic limestone causes the depression in carbohydrate digestibility.

EFFECT OF HIGH DIETARY POTASSIUM ON MAGNESIUM ABSORPTION BY LAMBS. G. L. Newton*, J. P. Fontenot and R. E. Tucker*. Depts. An.Sci. and BN, V.P.I., Blacksburg, Va.

An experiment was conducted with 12 wether lambs to determine the effects of feeding a high level of potassium on the metabolism of magnesium, calcium, sodium and potassium. All lambs were fed 800 gm. of a basal ration containing 0.5% potassium and 0.1% magnesium. Six of the lambs were fed 100 gm. potassium bicarbonate, in addition, which increased the potassium content of the ration to 5%. Following the introduction of the potassium bicarbonate in the experimental ration, eight successive 3-day balance trials were conducted. Blood samples were obtained prior to the beginning, at midpoint and at the end of the experiment. Feeding the high potassium level resulted in a significant depression in magnesium absorption during each of the eight balance trials with the decreases varying between 34 and 61%. Calcium absorption was not consistently altered by feeding the high potassium level. Apparent potassium absorption was higher ($P<.05$) during all trials and sodium absorption was higher ($P<.05$) during seven of the eight trials for the lambs fed the high potassium level, compared to the control lambs. At the end of the experiment, there was a trend for serum magnesium to be lower and serum potassium to be higher for the potassium supplemented lambs.

TECHNIQUES FOR STUDYING THE FACTORS AFFECTING ROOT EXUDATION OF ARACHIS HYPOGEA L. UNDER AXENIC GROWTH CONDITIONS. R. L. Rittenhouse. Dept. of Plant Pathology and Physiology, Va. Polytechnic Inst., Blacksburg, Va. 24061.

Peanut plants were maintained in sterile plexiglas isolator chambers to prevent utilization by microorganisms of root released compounds. Amino acids and carbohydrates released from the roots of peanut plants *Arachis hypogaea* L., var. NC-2 grown in flasks of complete nutrient solution were collected aseptically. The use of plexiglas chambers permitted the growth of peanut plants to maturity with greater ease of manipulation, maintenance, and operation than methods previously used.

Three separate experiments, each lasting six weeks, were performed. Gas mixtures were bubbled into the nutrient solution for 30 sec. every 12 min. for the duration of the experiment. The three gas mixtures were composed of: 1-CO₂(10%), O₂(21%), N₂(69%); 2-O₂(21%) and N₂(78%); 3-CO₂(10%) and N₂(90%). One group of plants received nitrogen gas only. Flow of gas mixtures was controlled automatically. Gas mixtures were sterilized by filtration before entering the chambers. Nutrient solutions containing the peanut root exudates were collected periodically for later analysis.

CHANGES IN FLUORESCENT XYLEM CONSTITUENTS OF ULMUS SPECIES INFECTED WITH CERATOCYSTIS UML (Buisman) C. Moreau. THE DUTCH ELM DISEASE FUNGUS. R. Jay Stipes. Dept. of Plant Pathology and Physiology, Va. Polytechnic Inst., Blacksburg, Va. 24061.

A common internal symptom of vascular wilt disorders such as Dutch elm disease is vascular discoloration. This phenomenon occurs in resistant (*Ulmus parvifolia*, *U. pumila*) as well as in susceptible (*U. americana*) elm species, and is believed to be caused by shifts in phenolic metabolism. The purpose of this study was to isolate and fractionate phenolic compounds in the wood, and to associate them, if possible, with the pathogenic process.

Twenty-five gram samples of infected and non-infected xylem from resistant and susceptible species were extracted in 95% ethanol. After further purification, the extracts were spotted on Eastman silica gel thin layer chromatograms and irrigated with benzene: acetic acid (5:1) in one dimension. Visualization of fluorescent compounds with ultraviolet light (254 m μ and 366 m μ) revealed striking differences. Two, 5 and 6 fluorescent compounds were observed in non-infected *U. americana*, *U. parvifolia* and *U. pumila*, respectively, while 8, 6 and 5 compounds were found in diseased xylem of the three species, respectively. The greater number present in the non-infected, disease-resistant species may act as pre-formed resistance factors, while those formed *de novo* in response to infection in the resistant species may function as phytoalexins.

CHEMICAL, PHYSICAL, AND MINERALOGICAL CHARACTERISTICS OF THE CECIL AND APPLING SERIES. G. Richardson, D.E. Pettry, C.I. Rich, R.L. Hodges, and S.S. Obenshain. Dept. of Agronomy, Va. Polytechnic Inst., Blacksburg, Va. 24061

A study was made in Hanover County, Va. of two soils occurring in deeply weathered granite gneiss of the northern portion of the Southeastern United States' Piedmont section.

Argillic horizons of the Cecil soils have greater clay content than the Appling soils. Both have contrasting but definite patterns of clay distributions in these horizons. Dominant clay determined by X-ray diffraction procedures is kaolinite; secondary clay present is vermiculite. Thin section analyses show definite signs of original rock structure in C horizons of both soils. Exchangeable cations and exchange capacities are in line with clay species present.

SOYBEAN RESPONSE TO GRANULAR SYSTEMIC AND FOLIAR INSECTICIDES. J. C. Smith. Res. Div., Va. Polytechnic Inst., Tidewater Res. Sta., Holland, Va. 23391.

Granular systemic insecticides were applied to soybeans as in-the-furrow, in-the-furrow plus layby, and as layby (only) applications to measure plant response in yield and quality. All treatments were apparently effective in preventing infestations of the Mexican bean beetle, but yield differences which resulted were not statistically significant. An average yield increase of 2.4 bu./A., and a quality increase of 0.5 grams/100 seed resulted from the application of sidedress, layby-applications of Furadan®, Temik®, Dasanit®, phorate, and disulfoton, respectively, applied at the rates of 1.0 and 2.0 lbs. active/acre. Slight reductions in yield resulted from planting-time applications of Furadan®, Temik®, phorate, and disulfoton. The yield reduction may have been caused by some observed phytotoxicity.

Single applications of foliar sprays and dusts to control a late infestation of Mexican bean beetles resulted in an average yield increase of 6.6 bu./A. and a grade difference of 1.8 grams/100 seed. The most effective treatment was Azodrin® at 0.5 lb. active/A. The least effective foliar treatment gave a yield increase of 3.3 bu./acre.

UPTAKE AND TRANSLOCATION OF THIA-BENDAZOLE AND BENOMYL APPLIED TO PHLOEM AND XYLEM TISSUES OF ALBIZIA JULIBRISIN DURAZZ. R. Jay Stipes. Dept. of Plant Pathology and Physiology, Va. Polytechnic Inst., Blacksburg, Va. 24061.

The potentialities of certain modern systemic fungicides are intriguing as they might hold promise in either the prophylaxis or therapy of vascular diseases of trees such as Fusarium wilt of "mimosa" (*Albizia julibrissin* Durazz.). The uptake and translocation of two antifungal benimidazole derivatives in mimosa seedlings were observed. In this study, 20% concentrations (w/w) in lanolin of thiabendazole (TBZ) and benomyl (methyl 1-(butylcarbamoyl)-2-benimidazole-carbamate) were applied to 5 cm areas of (a) intact bark, (b) phloem and (c) xylem tissues of healthy, actively growing plants. After 3 weeks, 4.0 g of leaves or roots and 0.45 g samples of phloem or xylem tissues were sampled above and below the application area. The compounds were extracted in a mortar and pestle with acetone + absolute ethanol (1:1). They were detected by a bioassay in which the extract-impregnated paper discs were placed on Czapek's agar. The test organism used as the overspray was *Vorticillium albo-atrum*. Translocation of benomyl and TBZ occurred upward only, and when applied directly to phloem and xylem tissues. Neither benomyl nor TBZ was detected in the roots. Benomyl, but not TBZ, was found in leaves of seedlings in which it had been applied to the phloem and xylem. These findings confirm the systemic nature of both compounds in mimosa when applied in a lanolin base.

AN EVALUATION OF HIGH LYSINE CORN FOR FINISHING SWINE.
H. R. Thomas and E. T. Kornegay. Dept. of Animal Science,
Tidewater Res. Station, Holland, Va. 23391 and Va. Poly-
technic Inst., Blacksburg, Va. 24061

One hundred forty four weanling pigs were randomly assigned by weight and sex to six feed treatments, replicated three times. High lysine corn rations were fed at the 14 and 16 percent protein level. Normal corn was fed at the 14 and 16 percent protein level with and without synthetic lysine supplementation. Peanut meal was used as the protein supplement for all treatments. Statistical analysis revealed that the normal corn ration supplemented with lysine produced significantly faster gains than the 5 other treatments. At the 14 percent protein level the high lysine corn ration and the normal corn ration supplemented with lysine were not significantly different from each other. However, they produced significantly faster gains than the normal corn rations fed at the 14 and 16 percent protein level. Rations containing normal corn and fed at the 14 and 16 percent protein levels were not different from each other but they produced significantly slower gains than the other treatments.

The analysis of the feed efficiency followed the same general pattern as the analysis of the average daily gains.

Average daily feed intake was significantly greater with the ration of normal corn, supplemented with lysine and formulated at the 16 percent protein level. The remaining treatments were not significantly different from each other.

Section of Astronomy, Mathematics, and Physics

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THE STRONG HYPERFINE INTERACTION IN PI-MESIC ATOMS. D. K. Anderson*. Dept. of Physics, Va. Polytechnic Inst., Blacksburg, Va. 24061

The origin of the induced strong hyperfine interaction in pi-mesic atoms is discussed. It is argued that the dominant contribution to this interaction is attributable to the static p-wave pion nucleon interaction with a much smaller contribution due to vector meson exchange. The magnitude of the interaction energy is also discussed. (Supported by NASA grant NGL-47-004-033)

INVESTIGATION OF THE EXCITATION OF THE 197KEV NUCLEAR LEVEL IN ^{19}F . Roger N. Blomquist* and Robert E. Welsh. Dept. of Physics, Col. of William and Mary, Williamsburg, Va. 23185

A Ge(Li) spectrometer was used to investigate the 197 kev gamma ray from $^{19}\text{F}^*$ (teflon, C_2F_{20}), as produced in a stopped negative pion beam. The target thickness was varied to determine whether the excitation results mainly from direct π^- inelastic scattering or a series of two reactions

$$\pi^- + \text{Nuc} \rightarrow \text{Nuc}' + l_n$$

$$l_n + 19\text{F} \rightarrow l_n' + 19\text{F}^*$$

The data were energy-analyzed in a 1600 channel pulse-height analysis system. Muonic background peaks, normalized by area to the muonic 2p-1s peaks in the data, were subtracted from the raw spectrum, and a gaussian function was fitted to the peak of interest by the method of least squares. The resulting integrated areas, normalized to pion stops in the target, and corrected for self-shielding, were found to increase with the target thickness. (Aided by NASA grant NGL-47-006-008)

DAMAGE TO GRATINGS BY ELECTRON BOMBARDMENT.
R. L. Bridgeman*, G. S. Ofeit, Melvin A. Pittman, and
Jacob Becher, Physics Department, Old Dominion College,
Norfolk, Virginia 23508

Performance characteristics of gratings blazed for the ultraviolet region have been studied. The gratings were subjected to a total electron dose corresponding to the maximum dose that might be received by an orbiting satellite in a one-year period. Tests were made with electron energies of 0.1, 0.5, and 1.0 MeV. The relative diffraction efficiency and reflection was determined before and after irradiation in the region 1048-1302 Å for master and gold replica gratings. The results indicated that no significant performance degradation was caused by the electron bombardment.

FLUX FLOW IN THIN SUPERCONDUCTING FILMS. J. D. Byrd* and B. S. Deaver, Jr., Physics Dept., Univ. of Va., Charlottesville, Va. 22903

In the presence of a perpendicular magnetic field, a thin superconducting film develops an array of normal spots where the field penetrates the film. Each spot is surrounded by a vortex current which confines one quantum, $\hbar/2e$, of magnetic flux within each normal spot. A current passing through the film will cause the vortices to move in a direction perpendicular to the current. These moving flux bundles produce a potential difference across the film and will produce the same voltage in a second film electrically insulated from the first but close enough for their flux arrays to be coupled. By placing two narrow secondary films across a primary channel, flowing an alternating current in one secondary film and observing the ac voltage in the other secondary film, we are studying the dynamics of flux flow in thin films. For the condition achieved so far, the flux appears to flow as an incompressible fluid. If the pinning can be reduced sufficiently, it should be possible to observe effects due to interaction between vortices and perhaps to observe waves in the flux array. (Research supported by the National Science Foundation)

EXPANSION OF THE ORION ASSOCIATION. William D. Cannell*. Leander McCormick Observatory, Univ. of Va., Charlottesville, Va. 22903

This paper reports on the astrometric investigation of the motions of 52 stars in the Orion Association. The observational material consists of 48 plates taken with the McCormick Observatory 26-inch refractor. Early epoch plates were taken in February 1968. The average time interval between early and late epochs is 42 years. All plates were measured on the U. S. Naval Observatory automatic measuring engine which has a setting repeatability of 1 micron. Reductions of the plates were made with the University of Virginia's Burroughs B5500 computer. Average plate constants for 24 pairs of plates indicate the reference frame is expanding slightly with an expansion age of approximately 5×10^5 years. This is about one half as much expansion as K. Strand found in 1958 when he made a similar astrometric study of the Orion association using 19 plates taken with Yerkes 40-inch refractor over a 50 year time interval.

PARTIAL WAVE CONTRIBUTIONS TO L_1 -SUBSHELL FORM FACTOR. D. R. Dorsey, Jr.* and G. S. Khadelvali, Dept. of Physics, Old Dominion College, Norfolk, Va. 23508

Partial wave contributions to inner-shell ionization by proton impact have usually been evaluated in low momentum transfer and large momentum transfer approximations. We have found that exact closed form expressions for the Bethe-Born form factor can be obtained in certain cases, for example, for transition from ns atomic state to the l=0 continuum state of the ionized electron. A calculation has been made for the atomic form factor for transition from L_1 subshell ($2s$ -state) of the L-shell to the l=0 continuum state of the ionized electron. An explicit expression for the form factor is obtained as a function of energy and momentum transfer to the atomic L_1 -subshell atomic electron.

EXCITATION OF H-ATOMS TO ns STATES BY FAST PROTONS. E. E. Fitchard* and G. S. Khadelvali, Dept. of Physics, Old Dominion College, Norfolk, Va. 23508

Recently numerical values for $1s$ -ns excitation cross section of H atoms have been obtained for a wide range of incident proton energies. We have obtained an asymptotic expression to order $1/v^6$ for the excitation cross section. Good agreement with the exact numerical results has been found for impact energies equal to or greater than 25 KeV. It is interesting to note that the coefficient of $1/v^6$ term contributes significantly for small and large n's for low incident energies in the 25 to 100 KeV range.

SIMULTANEOUS OPTICAL-X-RAY OBSERVATIONS OF SCORPIUS XR-1. L. W. Fredrick, Leander McCormick Observatory, Univ. of Va., Charlottesville, Va. 22903

On the night of 4-5 June 1968, MIT flew a pointed X-ray detector on a balloon which leveled out at 105,000 feet. Sco XR-1 was observed in the 20-200 keV range. Simultaneous observations were made in the optical region using the McCormick 32-inch reflector between 22:10 to 02:20 and between 01:30 and 03:30 on the 71-inch reflector at Victoria B.C. The balloon began to collect data at 22:20 and stopped at 03:50.

The X-ray data show no significant flares or bursts and a counting rate of 3 times the background when pointed at Sco XR-1. The optical observations showed short time scale flickering and a general brightening after 01:50.

POTENTIAL CHANGES ON STRESSED METAL SURFACES*. S. H. French and J. W. Beams, Dept. of Physics, Univ. of Virginia, Charlottesville, Va. 22903

Preliminary experiments are described which show that when stresses are applied to a metal the contact electromotive force of the metal surface changes. When the metal is stretched the changes in contact e.m.f. are negative in the elastic region but become erratic when plastic flow occurs.

ABSORPTIVE CORRECTIONS TO RADIATIVE PION CAPTURE. L. P. Fulcher and J. M. Eisenberg. Dept. of Physics, Univ. of Va., Charlottesville, Va. 22903

Several theorems concerning pionic strong interactions have recently been established using the assumption of soft pions. In particular, the Kroll-Ruderman theorem as it applies to radiative pion capture has been derived using the hypotheses of partially conserved axial-vector currents and of current algebras, as well as the assumption of soft pions. In nuclear physics the study of corrections to the soft pion limit is especially simple since nuclear models may easily be employed in their calculation. We calculate corrections to the Kroll-Ruderman theorem which are due to the absorption of the pion by the nucleus. We employ the interacting Fermi gas model of the nucleus and choose the one-pion exchange potential for the interaction between two nucleons. The pion-nucleon coupling constant must be readjusted in order to agree with the experimental double-nucleon emission rate. We find that the absorptive corrections then contribute less than 5 percent to the radiative pion absorption rate. (Work supported in part by National Science Foundation.)

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A SUPERCONDUCTING MAGNETOMETER FOR PRECISION FLUX MEASUREMENTS. W. L. Goodman* and B. S. Deaver, Jr., Physics Dept., Univ. of Va., Charlottesville, Va. 22903

Several measurements being undertaken in our laboratory, including the flux trapped in superconducting cylinders containing one or more weak links, the magnetization of multiply-connected superconducting cylinders and the susceptibility of superconductors just above the transition temperature, require measurements of extremely small magnetic flux changes in small samples. For these measurements we have constructed a magnetometer using a weakly-linked superconducting ring coupled to the inductor of a tank circuit resonant at 30 MHz. When the circuit is driven with a constant current source, the level of oscillation is a sensitive function of the magnetic flux through the ring. To use this high sensitivity, the environment of the magnetometer must be carefully controlled; particular attention has been given to temperature control, mechanical stability and magnetic and electromagnetic shielding. For samples approximately 0.05 cm diameter and 1 cm long, flux changes of 10^{-18} Webers can be detected. (Research supported by National Science Foundation)

RADIATIVE CORRECTIONS TO ELASTIC ELECTRON-PROTON SCATTERING[†]. G. Grammer and W. P. Trower, Physics Dept., Va. Polytechnic Inst., Blacksburg, Va. 24061

Quantum electrodynamics (Q.E.D.) can be used to describe electron-proton scattering if the structure of the proton is known. Since the electromagnetic interaction between the electron and proton is relatively weak, a perturbation technique can be used in the theoretical calculations. The first order approximation to the e-p cross section, corresponding to the exchange of one virtual photon, has been calculated by Rosenbluth¹. The next order of approximation, the so called "radiative corrections," includes several smaller effects: vertex corrections, vacuum polarization, bremsstrahlung, and the second Born term. All calculations of these effects to date have been made in the high-energy approximation (i.e. neglecting the electron mass)². We present here the results of our calculation of the radiative corrections to e-p scattering to third order in the fine structure constant with the electron mass included and which are therefore more correct at low energies and low four-momentum transfers.

[†]This work supported by the Res. Corp.

¹M. N. Rosenbluth, Phys. Rev. 79, 615 (1950).

²L. W. Mo and Y. S. Tsai, Rev. Mod. Phys. 41, 205 (1969).

RESCATTERING CORRECTIONS TO RADIATIVE PION ABSORPTION. Reed Guy* and J. M. Eisenberg. Dept. of Physics, Univ. of Va., Charlottesville, Va. 22903

We consider the problem in which a pion bound in a 1s atomic orbit is absorbed by the nucleus leading to the emission of a high-energy photon. Of particular interest to us is the possibility that before being radiatively absorbed, the pion may be scattered by a nucleon. This rescattering process is known to make important contributions to the nuclear absorption of S-wave pions with two-nucleon ejection. Its effects for radiative pion absorption in ^{180}W were calculated with second-order perturbation theory and the particle-hole formalism assuming that odd-parity spin-isospin nuclear states are excited by the absorption. Decreases were found in the transition rate of approximately 40 percent relative to the leading term given by the Kroll-Ruderman theorem. These results agree well with earlier less fundamental analyses of the pionic atom system based on an optical potential. (Work supported in part by the National Science Foundation.)

A MAGNETIC DENSITOMETER FOR CRYOGENIC FLUIDS. W. M. Haynes* and J. W. Stewart. Dept. of Physics, Univ. of Va., Charlottesville, Va. 22903

The densities of some cryogenic liquids, including particularly He^3 and He^4 , are to be measured by a new accurate technique. The magnetic densitometer which was developed by Beams and his co-workers at the University of Virginia for use at room temperature and atmospheric pressure is being modified for use at low temperature and high pressure. This technique can hopefully improve the presently available data for liquefied gas densities as functions of temperature and pressure which is now limited to about 0.1% precision by about two orders of magnitude. Data on densities, coefficients of thermal expansion, and compressibilities will be obtained over as wide range of temperature and pressure for the liquid phase as possible.

A Method of Measuring Particle Phase and its Application.
M. D. HOLT (introduced by H. O. Funsten) and D. B. Raiford*,
Virginia Associated Research Center, College of William and
Mary - 11970 Jefferson Avenue, Newport News, Va. 23606

Recent beam study and improvement programs at the Space Radiation Effects Laboratory 600 MeV Synchrocyclotron necessitated the development of some means for measuring the intensity distribution of charged particles in two external beam facilities. It was necessary to determine phase and real space distributions. In order to avoid the experimental complexity of large hodoscope arrays, a system consisting of two long movable scintillation counters was constructed; the overlap of these counters defines the active area at any position. The scanning was under the control of the SREL Data Acquisition computer system which presented the data as oscilloscope displays for each scan. While a point scan of this type is intrinsically slower than hodoscope arrays, the added flexibility and electronic simplicity make the system very attractive. This scanner has performed well on beam study programs at SREL and data from these runs will be presented.

MEASUREMENT OF BRILLOUIN SPECTRA OF LIQUIDS BY FOURIER TRANSFORM SPECTROSCOPY. C. V. Hughes*
and E. M. Kiess, Physics Dept., Hampden-Sydney
Col., Hampden-Sydney, Va. 23943

Monochromatic light that has been scattered from optically dense media exhibits spectral fine structure known as a Brillouin spectrum. In experimental investigations of Brillouin spectra, a Fabry-Perot interferometer is customarily used to resolve the spectrum. In this paper, the application of the method of Fourier spectroscopy to the measurement of Brillouin spectra is discussed. The advantage to be expected is that accurate line shape and width measurements appear to be possible. Preliminary experimental results are presented.

THE $\frac{1}{2}$ DIAGRAM AND THE PARTITION FUNCTION DIAGRAM OF GROUP SU(3). Yeu Pyng Hwu*, Dept. of Physics, Wytheville
Community College, Wytheville, Virginia, 24382

The relation between the partition function diagram and the $\frac{1}{2}$ diagram of group SU(3) is shown. This may offer an inter-connection between the algebraic and geometrical methods for dealing with weight multiplicity problem.

ELECTRON DIFFRACTION CONTRASTS OF VOIDS IN THIN FILMS. John Ingram*, (sponsored by Dr. Doris Wilsdorf), Dept. of Physics, Univ. of Va., Charlottesville, Va. 22901

The profiles of a thin crystal foil containing a spherical void have been calculated using the two beam dynamical theory of electron diffraction.

The image of the void as would be observed in an electron microscope is a result of the superposition of two contrast mechanisms. Firstly, the thickness contrast is due to the absence of scattering and absorption of electrons penetrating through the void. Secondly, the strain contrast is due to the distortion of the reflecting planes, when the void relaxes inward as a result of surface stress.

The dependence of the contrast on foil thickness, void depth and void radius is discussed, the foil being oriented at the exact Bragg condition.

NEUTRON DISTRIBUTION IN NUCLEI. D. Jenkins*. Dept. of Physics, Virginia Polytechnic Institute, Blacksburg, Virginia 24061.

Nuclear level shifts in pionic atoms are investigated as a means for measuring the neutron distribution in nuclei. Unlike muons and electrons which are used to measure the proton distribution in the nucleus, pions offer the possibility of measuring the neutron distribution because they interact with neutrons as well as with protons. The transition energy for the $3d^2P$ pionic x ray in Ni^{58} and Ni^{60} are computed by using an optical model potential to calculate the strong interaction shift in perturbation theory, and the results of the computation are compared to experiment. The strength of the pion-nuclear interaction is found to have a strong dependence on the nuclear radius, and the experimental data is consistent with the hypothesis of equal neutron and proton radii. However, uncertainties in the pion-nuclear interaction do not allow an accurate determination of the radius of the neutron distribution. (Aided by NASA Grant NGL-47-004-033)

DISLOCATION MODEL OF LIQUIDS. I. A. Kotzé* (now Dept. of Physics, Univ. of Pretoria, South Africa) and D. Kuhlmann-Wilsdorf, Dept. of Materials Science and Dept. of Physics, Univ. of Va., Charlottesville, Va. 22903

Based on a dislocation theory of melting, two dislocation models of the structure of metallic melts are proposed, one to describe unlimited glide on a set of parallel slip planes which retain the atomic order of the known crystallographic slip plane in the mother solid, the other describing unlimited pencil glide. In the latter case, straight rows of atoms parallel to the known slip direction are assumed to be retained in the same stacking order as exists in the corresponding solid, but with all the atomic rows slipping freely past each other. This second model is one form of Barker's tunnel model, and both of the models are uniquely linked to the crystal structure of the solid at its melting point. It is found that the radial distribution functions of the melts of lead, sodium, thallium, mercury, indium and tin can be satisfactorily described, each with one of the models such that a correlation exists between the slip behavior of the mother solid and the dislocation model that best describes the melt.

A COMPUTER PROGRAM FOR MODEL STELLAR ATMOSPHERES. Shiv S. Kumar and Robert J. Doyle*. Leander McCormick Observatory, Univ. of Va., Charlottesville, Va. 22903

Over the past two years we have been trying to develop a general computer program for model stellar atmospheres at the University of Virginia. The program computes flux-constant models for stars with effective temperature in the range 5000 - 10,000°K and the surface gravity in the range 10^3 - 10^4 . We are currently applying the program to a study of the atmospheric structure of degenerate stars. Some preliminary results for these stars will be presented.

This work has been supported in part by a grant from the Office of Naval Research.

ATOMIC PION CAPTURE IN METAL ALLOY by Diane Luckey* and Robert E. Welsh, Dept. of Physics, Coll. of William and Mary, Williamsburg, Va. 23185

A CuAl₂ alloy has been used to study the atomic capture of pions by the constituent elements of a metallic compound. The relative intensity of a specific mesic x-ray line from each element, corrected by comparison with the intensity of the same transition in a mixture of the two elements, was used to determine the ratio of the atomic capture probabilities. The capture ratio was measured to be 1.307 ± 0.515 , while the Fermi-Teller "2 Law" predicts this ratio to be 1.1.

Muons were also stopped in the CuAl₂ alloy. The atomic capture ratio for muons was found to be 1.74 ± 0.263 , in close agreement with previous measurements of the alloy.

(Aided by NASA grant NGL-47-006-008)

IDENTIFICATION OF SOLAR X-RAY SOURCES USING D LAYER IONIZATION BEHAVIOR DURING ECLIPSES. David D. Meisel, Leander McCormick Observatory, Univ. of Va., Charlottesville, Va. 22903

Reports of shortwave radio reception during the 12 November 1966 total solar eclipse have been used to determine the characteristics of a major source of D layer ionization. Analysis of the radio absorption shows the source was located near heliographic coordinates, $B = +7^\circ$, $L = 340^\circ$ and was probably less than 0.5° of arc in diameter. At the time of the eclipse, the source accounted for 40% of the radio absorption on a single, vertical pass through the D layer. Pre occultation behavior of the signal strength is interpreted by assuming a portion of the source X-ray flux was reflected at grazing incidence from the limb of moon. For point sources, such reflections have specific chromatic characteristics which were used to derive a crude source spectrum in the 3-140 Å range. X-ray absorption edges arising from the terrestrial atmosphere have been identified. A source temperature approximately twice that of the rest of the corona is indicated. A search for similar radio absorption behavior at three total eclipses between 1963 and 1968 has produced six additional identifications of strong solar X-ray sources.

SPLASHING OF DROPS ON SHALLOW LIQUIDS. Jay Lucas* (introduced by John W. Stewart) John Handley High School, Winchester, Va.

The action following the splash of a falling drop on a liquid surface depends upon the depth. When the height that the drop falls is always 75 cm and the depth of the receiving liquid is less than 5 mm, the resulting jet is very small and unstable. Below 3 mm there is hardly any jet at all. The maximum Rayleigh jet occurs at a depth of about 7 mm, and as the liquid depth is increased above that to 25 mm, the size of the jet decreases.

Winning paper, Physics Section, Virginia Junior Academy of Science.

PROTON ELASTIC SCATTERING FROM Ti⁴⁸ BETWEEN 2 AND 4 MEV.

J. A. Macdonald*, B. E. Stuck, T. D. Nainan & D. D. Long, Dept. of Physics, Virginia Poly. Inst., Blacksburg, Va. 24061

The Virginia Polytechnic Institute 4 MV Van de Graaff was used to take excitation functions of the Ti⁴⁸ (p,p) Ti⁴⁸ reaction in the range 2.0 - 3.8 Mev. Three silicon surface barrier detectors mounted at angles of 90° , 125° , and 165° relative to the incident beam direction were used to detect the outgoing protons. The targets were evaporated onto thin carbon backings. Compound nucleus resonances in v⁴⁹ have been observed. In particular, those resonances which are the isobaric analogues of levels in Ti⁴⁹ have been sought. The results were compared with those resonances observed through the Ti⁴⁸ (p,

) v⁴⁹ reaction.

* National Science Foundation Undergraduate Research Participant

ELECTRON IRRADIATION OF PHOSPHORUS DOPED SILICON. H. T. Morgan and T. E. Gilmer, Jr., Virginia Polytechnic Institute Blacksburg, Virginia 24061

A silicon sample with a phosphorus impurity concentration of 4×10^{15} atoms/cm³ was irradiated with .6 Mev electrons at room temperature. Some changes were observed in the infrared spectra of the sample after irradiation although no new bands appeared.

The resistivity of the sample was found to have increased from 1.6 ohm-cm before irradiation to over 2000 ohm-cm near the irradiated surface after irradiation. A graph of how resistivity varied with distance from the irradiated surface was plotted.

Annealing studies were done at temperatures between 100°C and 550°C. The damage in the crystal, as witnessed through resistivity measurements, was found stable at 100°C but unstable at 114°C. Plots of resistivity versus annealing time at several different temperatures were obtained. The annealing behavior indicated the presence of the silicon E center in the damaged crystal.

RELATIVE INTENSITIES OF K_α, K_β, K_γ and K_δ LINES OF MUONIC X-RAYS FROM Al by William D. Morris* and Robert E. Welsh, Dept. of Physics, College of William and Mary, Williamsburg, Virginia 23185

Relative intensities for muonic x-rays have been measured for the K-series of Al¹³. The values are very close to those predicted by pure radiative theory (i.e., neglecting Auger transitions) from low n levels. (Aided by NASA grant NGL-47-006-008)

ELECTRICAL BREAKDOWN OF THIN METALLIC FILMS. Robert B. Owen and H. Y. Loh, Department of Physics, Virginia Polytechnic Institute, Blacksburg, Virginia 24061

Thin films of silver, copper, and gold have been electrically broken down by high direct currents. The breakdown area was controlled by shaping the film so as to concentrate the heating effect. The resultant film structure has been studied. The breakdown pattern seemed to be quite universal among the three metals examined. A breakdown mechanism involving electron avalanche and ion migration has been proposed, and tested by applying a magnetic field to the films during breakdown. This arrangement has also rendered the effects of the Hall current visible.

A STUDY OF THE REACTIVITY EFFECTS OF THE V.P.I. NUCLEAR REACTOR. J. Wesley Parker* and A. Robeson, Dept. of Physics, Virginia Polytechnic Institute, Blacksburg, Va. 24061.

Once a reactor is critical and at a constant power level, the net reactivity at any time is zero. The major contributions to changes of reactivity in the V.P.I. Argonaut reactor are: (1) fuel and coolant temperature changes (2) graphite temperature changes and (3) xenon poisoning. The control rods have to be continuously positioned so that the total reactivity change of these parameters is nullified.

The reactivity effects of the fuel and coolant were combined into one temperature coefficient because for this investigation they are assumed to have simultaneous temperature changes. An experiment was conducted to measure the temperature coefficient of fuel and coolant which was found to be negative. The temperature coefficient for graphite was measured by installing heaters in two graphite blocks which were placed in the core. This experiment showed the reactivity effect of the graphite to be positive. The reactivity effect due to xenon poisoning was calculated using the xenon-iodine equations.

The results of these experiments and calculations were used to predict the position of the control rods during long power operation. The predicted position is in good agreement with the actual position.

⁶Li + d; DEFINITION OF LOW ENERGY GAMMA RAYS. A. F. Riedl* (sponsored by L. S. Anthony). Dept. of Physics, Roanoke Col., Salem, Va. 24153

Since the advent of the Li-Ge detector, many gamma ray energies have been determined to ± 10 eV instead of ± 1 keV. The d-d reaction for low bombarding energies on ⁶Li yields ⁷Li in an excited state. Similarly, the d-n reaction with ⁶Li yields ⁷Be in an excited state. Both of these reaction products decay to their ground states by gamma emission. The approximate gamma energies are 0.478 MeV and 0.431 MeV, respectively, as previously determined through the use of a 3x3 NaI(Tl) scintillation detector. By observing the same spectrum with a planar type Li-Ge detector, these gammas and their corresponding energy levels in ⁷Li and ⁷Be can be more precisely defined.

VARIABILITY OF THE SBFERT GALAXY NGC 1275. David M. Selove*. Leander McCormick Observatory, Univ. of Va., Charlottesville, Va. 22903.

Differential photometry was performed with a pulse counting photoelectric photometer attached to the 32 inch reflector at Leander McCormick Observatory indicates variability of the Sbfert galaxy NGC 1275. Measurements of the galaxy with respect to two nearby reference stars showed decreases in I, R, and V over a four month time span of 1/2 magnitude where rms errors in the rithm means for the galaxy were less than ± 0.02 magnitude. A fluctuation time scale of 10 days indicates a maximum source diameter of about 0.01 parsec.

AN ASTROMETRIC STUDY OF L726-8. Peter J. Shelus*. Leander McCormick Observatory, Univ. of Va., Charlottesville, Va. 22901

Plate material from the McCormick plate library covering the period August 1949 to September 1968 affords an opportunity to improve our knowledge of this system. Our analysis based on 81 plates yields a parallax of 0.44 ± 0.030 , somewhat larger than van de Kamp's value of 0.379 ± 0.010 . Van de Kamp's period of 200 years is essentially correct although our material suggests a somewhat longer period. The mass of the system is slightly less than $0.08 M_{\odot}$. The run of the residuals suggests a perturbation with a period of 16 years. If this perturbation is sustained, the perturbing body is of very small mass.

COMPUTER ANALYSIS OF ANGULAR CORRELATION DATA. R. L. Shotwell^a and K. J. Omega. Dept. of Physics, VPI, Blacksburg, Va.

Gamma-gamma angular correlation measurements often provide the necessary information for determining the relative spins of the nuclear states involved in the gamma ray transitions. A program has been written to analyze the raw data from such an experiment. The inputs are the number of coincidence counts and the angles at which the data was obtained as well as the accidental count rate.

The number of coincidence counts $w(\theta)$ may be expressed as a series of Legendre polynomials, i.e.

$$w(\theta) = A_0 + A_2 P_2(\cos\theta) + A_4 P_4(\cos\theta).$$

The A_0 , A_2 and A_4 are to be determined as well as their associated errors. Correction for finite size detectors are made and the spins are found from the corrected coefficients. In addition a plot of $w(\theta)$ versus angle is drawn using the computer estimated A's and the experimental data are included on the same plot. The V.P.I. IBM 360 computer, including the Calcomp 566 plotter was used for this project.

WEATHER PROSPECTS FOR THE TOTAL SOLAR ECLIPSE OF MARCH 7, 1970. John W. Stewart, Dept. of Physics, University of Virginia, Charlottesville, Virginia 22903

Next March 7, the Southeastern States, including a portion of Virginia, will lie within the path of totality for a solar eclipse. From the points of view of duration of totality (about 3 minutes) and altitude of the sun above the horizon (45° to 55°), this will be the finest eclipse of the 20th century visible from the Continental United States.

The central line of the eighty-odd mile wide band of totality extends northeastward from Apalachee Bay, Fla., to Virginia Beach, Va. Totality will be at about 1330 EST. A study of sunshine percentages and cloud cover data for a number of stations in and near the path of totality indicates that the probability of a completely clear view of the sun at eclipse time is approximately 40% at all points between Florida and Virginia. The interior sections of eastern North Carolina appear by a narrow margin to have the best chance.

After this one, the next total eclipse of the sun to be visible in Virginia will not occur until Sept. 14, 2099. States farther south will have several opportunities earlier in the 21st century.

PROTON ELASTIC SCATTERING FROM Cr⁵² BETWEEN 2 AND 4 MEV. B. E. Stuck, J. A. Macdonald, T. D. Nainan & D. D. Long. Dept. of Physics, Virginia Poly. Inst., Blacksburg, Va. 24061

Protons from the Virginia Polytechnic Institute 4 MV Van de Graaff accelerator were scattered from an enriched target of Cr⁵² supported by a thin carbon backing. Three silicon surface barrier detectors mounted at angles of 90° , 125° , and 165° with respect to the incident proton direction were used to observe the elastically scattered protons. The proton energy was slowly varied from 2.20 to 3.75 Mev with an overall energy resolution of about 1 keV. The cross section in this region is predominantly Rutherford, but observed anomalies correspond to compound nucleus resonances in Mn⁵³. The observed resonances are being analyzed to determine whether or not any are the isobaric analogues of levels in Cr⁵³.

THE DESIGN OF A HIGH PRECISION FARADAY CUP FOR ELECTRON SCATTERING^a. D. M. Stevens* and W. P. Trower. Physics Dept., Va. Polytechnic Inst., Blacksburg, Va. 24061

We propose to experimentally investigate the distribution of charge in the proton at radii out to 10^{-12} cm in order to check a recent theoretical speculation about the possible existence of a charge halo. By measuring the electron-proton absolute differential elastic cross sections to an accuracy of .25% at energies between 25 and 150 Mev we can check the validity of the halo prediction. Since the determination of the cross section depends on knowing the scattered and unscattered electron fluxes, beam monitoring is a major concern in this experiment. To obtain the highest possible degree of accuracy for determining the unscattered flux we have designed a Faraday cup to be used as a beam stop and as a current integrating device. Faraday cups capable of obtaining an overall accuracy of 1% have been constructed^b. Our experiment demands ten times greater accuracy. The design problems encountered in obtaining this degree of accuracy and our solutions are discussed.

*This work supported by Res. Corp.

^aNat. Science Fndn. Undergraduate Res. Participant.

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EXPERIMENTAL ERROR AND ELECTRON SCATTERING^a. B. C. Stringfellow and W. P. Trower. Physics Dept., Va. Polytechnic Inst., Blacksburg, Va. 24061

A first approximation to the differential cross section for electron-proton scattering was calculated by Rosenbluth, on the basis of the exchange of a single virtual photon between the electron and the proton¹. The Rosenbluth equation contains two unknown quantities, the electric and magnetic form factors, which are functions of only the four momentum transferred to the proton. These form factors describe the spatial structure of the proton's charge and magnetic current distributions. Since, in this experiment, we are only interested in determining the charge distribution of the proton, it is not necessary to know the magnetic form factor explicitly. Indeed, it can be eliminated by measuring the cross section at two different scattering angles, if the incident electron energy is adjusted to keep the four momentum transfer constant. However, to achieve unambiguous results for the charge distribution, it is necessary to make these measurements very accurately. Here we report an analysis of the effects of the constituent experimental errors, such as uncertainty in the beam energy and target thickness, on the accuracy of the resulting charge distribution measurement.

*This work supported by the Res. Corp.

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PRESSURE EFFECTS UPON ORDER-DISORDER PHENOMENA IN A COMPRESSIBLE ISING MODEL. C. C. Walton*, (sponsored by Dr. Doris Wilsdorf). Dept. of Physics, Univ. of Va., Charlottesville, Va. 22901

A compressible Ising model is applied in the Bragg-Williams approximation to describe order-disorder phenomena in various simple solids. A volume sensitive energy expression is assumed to consist of a sum of interaction terms, whose n_{ij}^{eff} term has a volume dependence of the form $\epsilon(V/V)^{\beta}$. The principal approximation of this model is that the various terms may be combined to yield three separate terms: 1) A term representing the ordering energy which is written in the form $\epsilon(V/V)^{\beta}$. 2) A term representing the volume sensitive excess energy which is written in the form $\epsilon'(V/V)^{\beta}$. 3) A term representing the volume insensitive excess energy which is written in the form $\epsilon_{\text{int}}(V)$.

The equilibrium equations are derived from the conditions: $(\partial \epsilon / \partial V)_T = 0$, $(\partial \epsilon' / \partial V)_T = 0$. The effects upon the order-disorder phenomena of a changing pressure at constant temperature, and a changing temperature at constant pressure, are described. Comparison between the present model applied to NH₄Cl and the experimental data for this orientational ordering ionic solid are made.

ON DIELECTRIC RESPONSE SUM RULES AND ENERGY LOSS IN REAL SOLIDS. K. C. Wiemer* and C. D. Williams*, Dept. of Physics, Va. Polytechnic Inst., Blacksburg, Va. 24060.

An inverse dielectric tensor characterizing the linear dielectric response of a system of interacting Bloch electrons of arbitrary symmetry, is defined and calculated by first-order time-dependent perturbation theory. The various components of this tensor are discussed with particular emphasis on the longitudinal component K_L^{-1} . The energy loss of external fields and charges is discussed in terms of this tensor and $\text{Im}K_L^{-1}$, and it is shown how the requirements of gauge invariance and particle conservation lead to a general sum rule of familiar appearance for $\text{Im}K_L^{-1}$.

MEASUREMENT OF THE SPECIFIC HEAT OF LIQUID HELIUM NEAR THE LAMBDA POINT IN THE UNDERGRADUATE LABORATORY. J. P. Wikso, Jr.* and B. S. Deaver, Jr. Phys. Dept., Univ. of Va., Charlottesville, Va. 22903

A cryostat suitable for a variety of low temperature experiments has been constructed for the Advanced Undergraduate Physics Laboratory of the University of Virginia and used for an experiment to determine the specific heat of liquid helium near the superfluid transition at 2.18°K. This particular experiment was chosen for several reasons: 1) It is a valuable introduction to the subjects of quantum fluids and the thermodynamics of phase transitions. 2) It is a conceptually simple experiment and requires neither sophisticated instruments nor major data reduction. 3) It demonstrates many techniques of low temperature physics and vacuum technology. The measurement was made using approximately 0.2 gm of helium in a copper container which was filled to approximately 2500 psi at room temperature and permanently sealed. The container was cooled to 1.5°K then thermally isolated; the sample was heated electrically at a known rate and the temperature measured with a carbon resistance thermometer. The temperature resolution was about 10^{-5} degrees and the specific heat determined within about one milli-degree of the lambda point. (Supported in part by the National Science Foundation Instructional Scientific Equipment Program)

AN ASTRONOMICAL LINE-PROFILE SCANNER. H. J. Wood*, Leander McCormick Observatory, Univ. of Va., Charlottesville, Va. 22903

A new photoelectric spectrum scanner has been developed for use with standard Cassgrain spectrographs. A 2 Å exit slit scans a 220 Å spectral range at a rate of 5 cycles per second. The spectrum is accumulated in a multi-channel pulse-height analyzer operating in the multi-scaling mode. Examples of stellar and nebular spectra will be shown.

Section of Biology

Forty-Seventh Annual Meeting of The Virginia Academy of Science
May 8-10, 1969, Fredericksburg, Virginia

PITUITARY CYTOLOGY IN THE LIZARD, *SCELOPORUS CYANOGENYS*.
Marie E. Anderson and Ian P. Callard, Dept. of Biology, Col.
of William and Mary, Williamsburg, Va. 23185.

Intact heads of normal non-pregnant *S. cyanogenys* were fixed in sublimated Bouin-Hollande for 7 days and decalcified in formic acid-formaldehyde prior to serial sectioning at 6 microns for pituitary cytology. Contiguous sections were stained using the Cleveland-Wolfe trichrome method, with PAS-Alcian blue at both pH 0.2 and 3.0, and PAS-Orange G. Examination of the sections revealed the following cell types according to tinctorial properties in the above stains. Acidophilis Type 1: Carnophil, PAS +ve, located in the cephalic lobe of the adenohypophysis (possibly prolactin cells) Acidophilis Type 2: Orangeophil, PAS -ve, , distributed throughout the adenohypophysis (possibly growth hormone cells). Basophilis Type 1: PAS +ve, Alcian blue +ve at both pH 0.2 and 3.0 (gonadotrophs, possibly FSH cells) Basophilis Type 2: PAS +ve, Alcian blue -ve (gonadotrophs, possibly LH producers). Basophilis type 3: PAS +ve, Alcian blue +ve at only pH 3.0 (possibly thyrotrophs).

These results suggest that cell types in the reptilian hypophysis may be differentiated using techniques which have proved to be of value in cytological investigations of the pituitary gland of other vertebrates. (Supported by NSF GB-6917).

PROTEIN SYNTHESIS IN SEEDS OF *PINUS LAMBERTIANA*. L. B. Barnett and R. E. Adams.* Dept. of Biochemistry and Nutrition and Dept. of Forestry and Wildlife, Va. Polytechnic Inst., Blacksburg, Va. 24061.

Several aspects of protein biosynthesis in seeds of *Pinus lambertiana* have been investigated in an attempt to gain some insight into the dormancy mechanism which is operative within these seeds.

1) Sucrose density centrifugational analyses of ribosome preparations from the female gametophyte revealed a build up of polyribosomal structures during imbibition.

2) Investigations of ribonucleic acid synthesis *in vivo* showed that the greatest incorporation of nucleic acid precursor into ribonucleic acid occurred with the stratified seeds.

3) Whereas the female gametophyte failed to yield a cell-free amino acid incorporating system, the embryo cell-free system was able to produce acid insoluble material using a synthetic messenger-ribonucleic acid. This cell-free system from the embryo was characterized.

(This work was supported by Hatch Project 616070 and McIntire-Stennis Grant No. 636120.)

EVOLUTIONARY TRENDS IN THE PLANT FAMILY MYRICACEAE. J. R. Baird. Dept. of Biology, Clinch Valley Col. of the Univ. of Va., Wise, Va. 24293

Comparative studies were made of the internal anatomy and floral morphology of all species of the family Myricaceae that are native to North America (north of Mexico). Of the characteristics of the internal anatomy that were examined, evolutionary trends of eleven have been generally established and are widely accepted. These characteristics include: vessel element length, diameter, distribution, outline, and grouping; types of perforation plates; types of imperforate elements; type and cellular composition of wood rays. The state of each character was statistically analyzed and used in the derivation of an Advancement Index Value, a method adapted from Sporne, K.R. (*New Phytologist*, 48:259-276)

A similar Advancement Index Value was derived from seven characteristics of floral morphology. Interpretation of these characteristics is based on widely accepted theories of floral reduction.

The cumulative Advancement Index Value strongly indicates that *Myrica gale* and *Comptonia peregrina* represent two divergent lines of evolution. All other species constitute a distinct and relatively primitive group. The extent of divergence supports the recognition of three genera within the family.

PERSISTENT SEASONAL VARIATIONS IN THE DIURNAL CYCLE OF EARTHWORMS. Miriam P. Bennett. Dept. of Biology, Sweet Briar Col., Sweet Briar, Va., 24551.

An annual cycle, based on the differences between the speed of locomotion around midday and in the evening, was found for *Lumbricus terrestris* L., maintained in the laboratory under constant conditions of light and temperature, and studied during parts of 1965, 1966, 1967 and 1968. During each month, the worms were faster in the evening than at noon, but this difference varied through the year with its high (47%) recorded for August, and its low (18%) in December and January. In addition, during part of the year, the differences between midday and evening were greater for a 15-day period centered on full moon than for a block of 15 days centered on new moon. Therefore, seasonal changes in lunar correlations are also indicated. (Aided by a grant from the Committee on Faculty Research, Sweet Briar Col.)

COLLECTED HERPETOFAUNA IN CAROLINE COUNTY, VIRGINIA.
D.J. Brittle, Caroline High School, Bowling Green, Va.
22H27

Little herpetofauna has been collected, preserved and identified in Caroline County, Virginia. Some brief studies were made by Collins (VHS-B #8) in summer months from 1963-1966. Since 1966, no information has been added to the Virginia Herpetological Society records.

For the past two years, the writer has observed, collected and preserved several species of reptiles and amphibians. Combining Collins' notes from 1963-1966 with the information on fauna collected or observed since then, a list was obtained as follows: 15 snakes, 3 lizards, 5 turtles, 7 salamanders, 8 frogs and toads.

County records since 1966 include: Northern Red Salamander, Five-lined Skink, Eastern Worm Snake, Mole Snake (Brown King Snake), Northern Brown Snake, River Cooter, and Florida Cooter.

Since knowledge of Virginia reptile and amphibian life forms is by no means complete, this study is being conducted to increase the information concerning the range and distribution of herpetofauna.

EXPERIMENTAL HOME RANGE STUDIES IN THE LIZARD, *SCELOPORUS UNDULATUS*. G. R. BROOKS. Dept. of Biology, Col. of William and Mary, Williamsburg, Va. 23185.

The average home range areas for adult male and female *Sceloporus undulatus*, as observed in a natural population, were 61 m² (N=6; S.D.= 14m²) and 47 m² (N=6; S.D.= 14m²) respectively. An escape proof pen (16m x 16m) was constructed and first stocked with 2 adult males and 2 adult females. After 3 weeks their respective average home range areas were 93m² and 26m². Another 4 adults (2 males and 2 females) were then released in the pen. The increase in density resulted in a significantly smaller home range area for the original males (65m²) and a slight, but non-significant, increase in that of original females (31m²).

HYPOTHALAMIC CONTROL OF ADRENAL AND GONAD FUNCTION IN THE LIZARD, *SCELOPORUS CYANOCENYS*. Ian P. Callard, Edgar Willard, III and William F. McConnell. Dept. of Biology, Col. of William and Mary, Williamsburg, Va. 23185.

Lizards received steroidically placed implants of corticosteroid, estrogen or cholesterol in the hypothalamus. The results indicate that centrally located betamethazone (a corticosteroid) inhibit metopirone induced adrenal hypertrophy in male lizards. Further, lesions of the hypothalamus had similar effects in inhibiting adrenal growth. Lesions and implants in the antero-medial hypothalamus and in the median eminence were most effective. Hypothalamic estrogen implants did not interfere with ovarian follicular growth, but did inhibit ovulation and reduce ovarian steroid secretion as indicated by a reduction in oviduct size in the presence of the estrogen implant. These findings extend to the cold blooded vertebrates the probability that steroid sensitive units in the brain monitor levels of steroid hormones in the blood. These steroid sensitive cells function homeostatically to control both the adrenal gland and the gonad via the pituitary gland. (Supported by NSF GB-6917 and the Col. of William and Mary.)

SELECTION FOR MODIFICATION OF RECOMBINATION FREQUENCY IN *DROSOPHILA MELANOGASTER*. J.P. Chinmici. Dept. of Biology, Univ. of Va., Charlottesville, Va. 22901

Selection for modification of recombination between 2 sex-linked genes (*sc* and *cv*) in *D. melanogaster* has been practiced, using a selection regime consisting of alternating generations of family and mass matings and employing both family and chromosomal selection of the appropriate type. After 27 generations of two-directional selection, the *sc-cv* crossover frequency has been significantly changed in both directions, increasing from .154 to .191 ($b=.04,1687, P<.001$) in the high line and decreasing from .154 to .078 ($b=-.03248, P<.001$) in the low line.

Simultaneous chromosomal selection for non-recombination in 2 adjacent regions to *sc-cv* produced nearly identical decreases in both of these regions in both of these lines, indicating that the change in recombination frequency between *sc* and *cv* is due to a real increase (or decrease) in the number of crossover events in the X-chromosome and not to compensatory loss (or gain) of crossover events in adjacent regions.

ULTRASTRUCTURE OF THE PHLEMM OF *PINUS SPP.* RHYTIDOME. J. F. Coder* and R. E. Martin. Dept. of Forestry and Wildlife, V.P.I., Blacksburg, Va. 24060

The cell wall ultrastructure of phlemm cells (cork cells) from the periderm layers of selected pines, *Pinus spp.*, was studied using both the light and electron microscopes.

The periderm is a protective secondary tissue of plants. One function of this protective layer is to provide a barrier against moisture loss from the stem. This water barrier is attributed to the presence of suberin within the phlemm cell walls.

Sitte, working with the cork cells from the bark of *Quercus suber*, found that these cell walls consist of alternating layers of wax and suberin. He also observed pore-like structures which he termed plasmodesmal pores.

From this study it was found that the phlemm cell walls of the pines used were made up of alternating layers similar to those seen by Sitte. A study of the material making up these layers was not undertaken. The presence of pore-like structures was also noted.

STROBLATION OF *CHRYSAORA QUINQUECIRRHA* POLyps IN THE LABORATORY. Harold N. Cones, Jr. Dept. of Biology, Christopher Newport Col., Newport News, Va. 23601.

The siphistoma of *Chrysaora quinquecirrha* was induced to strobilate in the laboratory. Detailed description of the process is given.

Just prior to strobilation, the goblet-shaped polyp undergoes color change and clefting. Each siphistoma typically releases five ephyrae. Terminal tentacles are resorbed during strobilation and appear near its completion at the base of the strobila.

Upon release, ephyrae swim to the surface and attempt to maintain their position there. Strobilation is normally complete in 20-25 hours after clefting. All stages survive well on *Artemia*, enchytraeids, ground ctenophores, and similar food.

STIMULI INVOLVED IN THE ESTABLISHMENT AND MAINTENANCE OF THE COMMENSAL RELATIONSHIP BETWEEN PINNOTHERES MACHILATUS SAY AND AQUINUCTIN IRRADIANS CONCENTRICUS. Anne Eidenmiller, Dept. of Biology, Mary Washington Col., Fredericksburg, Va. 22401.

The pea-crab *Pinnotheres machilatus* Say is a commensal of the bay scallop *Aequinectin irradians concentricus*. A study was made using invasive stage crabs of this species to determine what stimuli release the behavior which results in the crab finding its host and remaining within it and to observe behavior of both crab and scallop during entry attempts to determine what if any ritualized behavior is involved.

Categories of stimuli investigated included currents, and visual and tactile stimuli; chemosensory stimuli have been previously established. It was found that the crabs show a marked response to currents, that visual stimuli are not significant, and that tactile stimuli are relevant to the responses. Responses of the crab that tend to maintain the relationship include strongly positive thigmotaxis. In entry attempts, the behavior of the scallop tends to favor entry of the crab; there are no obvious consistencies in the crabs' entry behavior.

FURTHER STUDIES OF THE FEEDING RESPONSE IN THE ONUPHID POLYCHAETE *DIPATRA CUPREA*. R. A. Graham and C. P. Mangum, Dept. of Biology, Col. of William and Mary, Williamsburg, Va. 23185.

The onuphid polychaete *Dipatra cuprea* continually tests the medium for the presence of food stimuli by drawing large volumes of water into its tube. When threshold stimuli are encountered, the worm gives a feeding response that results in ingestion.

The response can be induced in the laboratory by directing a diffuse jet of clam juice towards the anterior opening of the worm's tube. There are several substances in the juice from the clam *Mya arenaria* that elicit the response: 1) the amino acids serine, tyrosine, valine and phenylalanine and 2) a larger molecule of approximately 17,000-20,000 molecular weight. This molecule does not occur in *Merencaria merencaria*.

An investigation of the nature of this larger molecule is in progress. More precise estimates of molecular weight are being made by dextran gel chromatography, and the structure of the molecule is being characterized. Presently the molecule is believed to be a polypeptide, but other possibilities have not been fully ruled out. (Supported by NSF GB-6884).

CIRCLING BEHAVIOR IN *PEROMYSCUS MANICULATUS BAIRDII*. J. H. Heard* and S. R. Gemborys, Dept. of Biology, Hampden-Sydney Col., Hampden-Sydney, Va. 23947.

Several prairie deer mice (*Peromyscus maniculatus bairdii*) observed in small confined populations ran circular patterns. Moreover, they ran these circles in a specific direction, either right or left.

As a means of testing this behavior, adult deer mice and their offspring were observed for 5 minutes in an 82 by 82 by 40 inch arena by means of closed circuit television. Record was made of number and direction of circles and turns as well as size of circles.

Of 26 adults, 12(46.2%) showed a right pattern; 6(23.1%) showed a left pattern; and 8(30.8%) showed no pattern. Of 65 young adults, 32(49.3%) ran right circles; 11(16.9%) ran left circles; and 22(33.8%) showed no pattern. It was concluded that:

1. Most *P.m. bairdii* show consistent patterns of circling behavior under laboratory conditions.

2. Mice which consistently circle in one direction also turn in this direction when reversing direction or avoiding obstacles.

3. *P.m. bairdii* shows this activity only when sexually mature.

4. Circling rates tend to increase with age after the onset of sexual maturity.

EFFECT OF PARIELATECTOMY ON O₂ CONSUMPTION, HEART RATE AND VENTILATORY RATE IN THE LIZARD, *Sceloporus occidentalis*. G. Francis and G. R. Brooks, Dept. of Biology, Col. of William and Mary, Williamsburg, Va. 23185.

The parietal eye, a functional photoreceptor, is a well developed structure in the lizard, *Sceloporus occidentalis*. A nerve from the retina of the parietal eye specifically connects indirectly with the hypothalamus. Parietalectomy results in increased activity, spermatogenesis and thyroid activity. These increases should be accompanied by an increase in O₂ consumption and subsequent increase in heart rate and ventilatory rate. Measurements of these parameters in 3 groups of 8-10 individuals were taken after a 30 day experimental period. Results at 35°C were as follows: O₂ consumption in $\mu\text{l}/\text{gm}/\text{hr}$: parietalectomized ($x=0.24$; S.D.=0.02), sham-parietalectomized ($x=0.27$; S.D.=0.03) and controls ($x=0.29$; S.D.=0.01); heart rate: parietalectomized ($x=182$; S.D.=10), sham-parietalectomized ($x=182$; S.D.=7), and controls ($x=189$; S.D.=8); ventilatory rate: parietalectomized ($x=44$; S.D.=2), sham-parietalectomized ($x=35$; S.D.=2) and controls ($x=36$; S.D.=2). None of the differences are significant.

A QUANTITATIVE ANALYSIS OF LIGNIN DISTRIBUTION IN THE DEVELOPING XYLEM OF *TSUGA CANADENSIS* L. G. A. GROZDITS, Dept. Forestry and Wildlife, V.P.I., Blacksburg, Va. 24061.

This paper is a report on one phase of a series of investigations dealing with the mechanism of cell wall formation in secondary xylem of eastern hemlock. The objective of this study was to assess quantitatively the lignification process in the cell walls of tracheids.

On the basis of microscopic observations, and density and lignin distributions, four phases of tracheid development could be identified. These were cell division, cell enlargement, cellulose frame deposition and lignification. With the aid of the polarizing microscope, secondary cell wall formation could be divided into four distinct phases. These were the stages of cellulose frame deposition in the outermost (S_1), part of the middle (S_2 part), the completely developed middle (S_2 complete) and the innermost (S_3) layers of the secondary wall.

The rate of lignin deposition increased sharply after the cellulose frame formation in the S_1 . A further increase in lignin content, but at a smaller rate, is found after the completion of the cellulose frame deposition of the S_3 layer. The cellulose frame is deposited in the sequence of P (primary wall), S_1 , S_2 , and S_3 layers. Lignification follows this sequence with one or two layers behind. Lignin appears to be the final product closing all events of tracheid metabolism. Therefore, the last metabolic process in the developing tracheid is the lignification of the S_3 layer.

THE FUNCTION OF COELOMIC HEMOGLOBIN IN THE CHESAPEAKE BAY BLOODWORM. R. J. Hoffmann and C. P. Mangum, Dept. of Biology, Col. of William and Mary, Williamsburg, Va. 23185.

Since there is no vascular system in the bloodworm *Glycera dibranchiata*, it might appear that the coelomic cell hemoglobin replaces a vascular pigment as an oxygen transport protein or as an oxygen store. However, oxygen consumption measurements at 10 and 20°C on worms with hemoglobin unblocked and then blocked with carbon monoxide indicate that transport cannot be very great. Furthermore, studies under anoxic conditions show that the hemoglobin apparently cannot function as an oxygen store since the hemoglobin is still largely combined with oxygen even after 24 hour exposure of the worm to anoxic conditions, indicating that the pigment does not unload its bound oxygen even under the most severe environmental conditions. Lack of environmental oxygen also causes an immediate cessation of ciliary circulation of the cells through the gills.

The function of coelomic hemoglobin does not duplicate that of the vascular hemoglobins in other animals. The possibility of an oxygen transfer system between the coelomic pigment and the two other hem proteins present (myoglobin in the proboscis and nerve hemoglobin in the ventral nerve cord) is currently under investigation. (Supported by NSF GB-6884 and GY-4185).

FEEDING BEHAVIOR IN PLANARIANS SUBJECTED TO LIGHT STIMULATION
Marie M. Jenkins, Dept. of Biology, Madison Col., Harrisonburg, Va. 22801

The purpose of this study was to determine whether the negative response of planarians to light could be overcome by coupling light with a food reward. Experimental *Dugesia dorotocephala* were kept in darkness; controls were exposed to a diurnal day/night cycle. All were fed three 30-minute periods per week. Time required for each worm to reach the food was recorded. Sexually immature planarians learned to associate light with food more readily than sexually mature ones. Asexual planarians fed at mid-morning made significantly better scores than sexual groups fed at mid-afternoon. After five weeks an eraser, instead of food, was presented with the light. Morning-fed groups approached the eraser more quickly than afternoon-fed ones at the first presentation and less quickly at the second presentation. That light, rather than diffusing food juices, served as a stimulus was evidenced by the fact that planarians approaching the eraser protruded pharynges and attempted ingestion. Results obtained indicate that planarians can learn to associate food position with light stimulation; that immature planarians learn more readily than sexually mature ones; and that the time of day an experiment is performed has an important bearing on planarian behavioral responses. (Assisted in part by a Sigma-XI Research Grant.)

A PRELIMINARY INVESTIGATION OF THE EFFECT OF PARA-CHLOROPHENYLALANINE ON INTESTINAL MOTILITY IN THE RAT.
Dan Kimbrough and Vern Meyer, Dept. of Biology, Virginia Commonwealth University, Richmond, Va. 23220

Past work has shown that when strips of rat duodenum are excised and perfused *in vitro*, peristalsis continues, its rate being largely influenced by the concentration of serotonin (5-hydroxytryptamine) locally present. It has been postulated that, although serotonin synthesis and storage might occur primarily in the gut of the mature animal, it might originate elsewhere in the immature animal. Such an additional site could serve as a precursor-supply center for other sites of potential serotonin synthesis. Since the mammalian midbrain is thought to contain the richest tissue concentration of serotonin, the present study has been concerned with observing the effect that para-chlorophenylalanine, which inhibits synthesis of brain serotonin, might have on intestinal motility. The preliminary results of this study have been encouraging.

INFLUENCE OF CRAYFISH EYESTALK EXTRACT ON THE RESPIRATORY ENZYME ACTIVITY OF SELECTED TISSUES OF THE RAT. W. L. Mengelker and Wayne L. Carpenter.* Department of Biology, Bridgewater College, Bridgewater, Virginia 22812.

Eyesstalk extracts from *Cambarus bartonii* were prepared by homogenization in phosphate buffer, followed by centrifugation at 0°C for 60 minutes at 8000 x g. The effect of this extract on the succinoxidase and cytochrome oxidase systems of rat liver, brain, heart and kidney was investigated using the Warburg technique.

Significant increases in brain cytochrome oxidase activity was noted. The influence of the extract is not altered by either dialysis, or by freezing for a maximum of two weeks. Freezing for a three month period or boiling destroys all extract activity.

EFFECT OF AGE ON REPRODUCTIVE ACTIVITY IN *DUGESIA DOROTOCHEPHALA*. Marie M. Jenkins, Wm. F. Jones, Sarah P. Feulner. Dept. of Biology, Madison Col., Harrisonburg, Va. 22801

Sexually mature individuals of *Dugesia dorotocephalo* were allowed to interbreed during their lifetime with others hatched from the same cocoon. The planarians were kept in artificial pond water at a constant temperature of 68° C. and were fed beef liver every 4-5 days. Data obtained are presented on the basis of 15-week intervals, beginning from the date of emergence. The maximum number of cocoons was deposited during the eighth interval. The maximum number of living young was produced from cocoons deposited during the fourth interval. The average number of living young end of F_2 offspring per F_1 worm ranged from a maximum during the eighth interval to a minimum during the fourteenth interval. Cumulative totals of F_2 individuals produced per interval show a typical sigmoid curve distribution with the steepest slope during the second year of parental life. Eight sexual worms produced a total of 2,785 offspring during the four years of reproductive activity. No viable cocoons were produced after the beginning of the seventeenth interval. Although fissioning races of *Dugesia dorotocephalo* may undergo regeneration, individuals of the sexual race which do not fission exhibit evidences of senescence which culminates in death. (Supported in part by PHS Grant HD-02217 end by a Sigma-XI Research Grant.)

PHOTOPLANKTON COMPOSITION OFF THE SOUTHEASTERN COAST OF THE UNITED STATES. H. G. Marshall, Dept. Biology, Old Dominion College, Norfolk, Va. 23506

The seasonal distribution and composition of phytoplankton is discussed for shelf waters. The Gulf Stream and the northwest Sargasso Sea between December 1964 and May 1968, along transects extending from coastal waters seaward. The diatoms predominated in waters over the continental shelf to the western boundary of the Gulf Stream, where their numbers declined rapidly into the Sargasso Sea. The major diatoms were *Skeletonema costatum* and *Rhizosolenia alata*. *Coccolithophores*, *pyrophyceans*, and *silicoflagellates* were in low concentration over the shelf, but were most abundant in the Gulf Stream. Major *coccolithophores* in the Gulf Stream were *Coccolithus huxleyi*, *Gephyrocapsa oceanica*, *Syracospheca mediterranea*, and *S. pulchra*. The total phytoplankton populations and numbers of species were less in the Sargasso Sea than in the shelf waters, or in the Gulf Stream. Several species were unique for each of these waters, with many having a seasonal appearance. The *coccolithophores* and *pyrophyceans* were the major components of the Sargasso Sea phytoplankton, where relatively small numbers of diatoms were present.

THE EFFECT OF SLEEP DEPRIVATION ON THE SEROTONIN LEVEL OF THE RAT PINEAL GLAND. Vern E. Meyer, Dan Kimbrough, and John A. Rosecrans.* Dept. of Biology VCU, Richmond, Va.

Hale Wistar strain rats were established under an artificial photoperiod of 0600 to 1800 hrs. Activity counts and defecation rates were determined for each rat; and they were placed in two equal groups, high defecators and low defecators. Each rat was ranked in activity from high to low in each group. Every other rat in each rank was chosen as the control to assure a close approximation of activity rates to the corresponding sleep deprived rats.

As previously found in other research, the peak serotonin level in the pineal was at 1300 hrs. After sleep deprivation each rat was killed and the pineal assayed, using the Anilco-Bowman Fluorometer.

It was found that the high defecators had a lower serotonin level than the low defecators; and in each group the sleep deprived rats had a lower serotonin level than the controls.

The photoperiod was in effect for 30 days prior to assay, each sleep deprived rat was sleep deprived for 24 hrs. and killed at exactly 1300 hrs.

THE DISTRIBUTION AND BEHAVIOR OF AN INTERTIDAL FISH. R. S. MOLLICK. Dept. of Biology, Christopher Newport Col., Newport News, Va. 23601

Clinocottus analis Girard, the wooly sculpin, is a strongly demersal cottid fish inhabiting the intertidal zone of southern California. The major purposes of this integrated field and laboratory study were: (1) to determine the distribution and abundance of *C. analis* in representative tide pools, (2) to determine what substrate types, in terms of background colors and textures, are available in the tide pools, (3) to determine whether the distribution of *C. analis* on the available substrates is random or selective, (4) if selective, to determine how *C. analis* chooses substrates, and (5) to consider reasons why such choices are made based on pertinent observations of its behavior in the laboratory and in nature.

In general, *C. analis* prefers dark, densely matted plant substrates or the free spaces between rocks to low or flat substrates of any shade. Substrate selection is made on the basis of visual rather than chemical or tactile cues and is not influenced by the presence of food organisms. The substrate preference behavior of *C. analis* is of obvious survival value because an individual in dark areas between rocks or in an algal mat, aided by its protective coloration, is out of sight and reach of predators.

THE PATTERN OF RNA SYNTHESIS DURING DEVELOPMENT OF STOBLOBLASTS OF THE BRYOZOAN, PECTINATELLA MAGNIFICA.

Virginia K. Proud* and Robert E. Black, Biology Dept. Col. of William and Mary, Williamsburg, Va. 23185

Stobloblasts collected in the fall were stored at 4°C. Germination was induced by returning them to 25°C. Total RNA and DNA increase markedly during development, beginning approximately at the time of germination. A lesser increase is noted during budding (36–72 hours after germination). Incorporation of [¹⁴C]-uridine into TCA-insoluble precipitates after one-hour labeling periods increases throughout development. Using 12-hour labeling periods, incorporation of uridine into both polyribosomes and ribosomes was noted in stobloblasts beginning 24–36 hours prior to germination. Polyribosomes and free ribosomes increase in the 10,000 g supernatant fraction before germination, based on wet weight of stobloblasts. Actinomycin D (up to 50 μg/ml) did not significantly affect germination. At 25°C/ml tentacle development was somewhat abnormal and budding was blocked. At 50°C/ml development of the primary polypide was drastically inhibited. RNA synthesis is apparently required for normal development.

THE INFLUENCE OF A CLEARCUT AREA ON A CONFINED DEER HERD IN A PREDOMINANTLY GRASSLAND HABITAT. J. L. Sandt*

(sponsored by Dr. H. S. Mosby) Graduate Fellow, Dept. of Forestry and Wildlife, Va. Polytechnic Inst.,

Blacksburg, Va. 24061

A 25-acre tract of mature hardwoods was cut in the winter of 1968 in the Radford Army Ammunition Plant, a 2,322-acre area enclosed by a 7½ foot high fence. The area is approximately 80% open grassland.

Responses by deer to the clearcut were measured by changes in home range and food habits analysis. No seasonal changes in movements or changes in size of home range were found. Rumen analysis showed that the food habits of deer using the clearcut area were the same as those not using the clearcut area. Significant seasonal changes in food habits were found.

PARASITES OF THE REPTILES AND AMPHIBIANS OF DOMINICA, WEST INDIES. E. NICHOLLS* AND G. R. BROOKS. Dept. of Biology, Col. of William and Mary, Williamsburg, Va. 23185.

The parasitic worms of 13 species of herptiles from Dominica, West Indies, were identified to genus. Two trematodes (*Omnipharynx analis* n.g., n.sp. from *Anolis ocellatus* and *Mesocoelium* sp.), one cestode (*Ophiotectaenia* sp.), six nematodes (*Theleandros* sp., *Pharyngodon* sp., *Oxolaimus megalothylax*, *Cruzia* sp., *Hastospiculum* sp., and *Terranova* sp.), one pentastomid (*Forocephalus* sp.) and one oligacantho-rhynchid acanthocephalan were discovered. The number of parasitic species per host was low compared to related continental host parasite loads. (This study supported by the Bredin-Archbold-Smithsonian Biological Survey of Dominica.)

AN IMMUNOCHEMICAL STUDY OF THE EPIDERMAL LANGERHANS CELLS OF THE MOUSE. Willie M. Reams, Jr. and P. P. Greco† Dept. of Biology, Univ. Richmond, and Div. Dermatology, Med. Col. of Va., Richmond, Va. 23219

Langerhans cells (LC) originally were described in the epidermis. For the past hundred years, nothing conclusive has been found as to their origin and function. That the LC was related to the pigment cell was shown to be untrue by Gressenbach, et al (1968) and Reams (1968). As cells which ultrastructurally look like epidermal LC have been seen by several workers in the spleen and histiocytic tumours, it has been purported that the LC may be a phagocyte derived from thymoblasts.

To prepare antilymphocyte serum (ALS), whole thymoblasts were obtained from the thymuses of young mice and injected into mature male rabbits. In due time, the ALS was recovered from the rabbits and stored frozen. Mature mice were injected with the ALS following a blood count. ALS was injected every third day until the blood counts showed a marked decrease in the number of lymphocytes. Fluorescent examination was made of the skin, thymus and nodes. Numerous checks were made for the activity of the ALS.

The ALS showed a high fluorescence in the thymus and nodes, but the epidermal LC were negative. It was concluded that these LC are not related to thymoblasts. (Aided by NIH grant AM-11864. The work was done in part at the Virginia Institute for Scientific Research.)

THE EFFECTS OF TEMPERATURE ON THE METABOLISM AND BEHAVIOR OF AN ANTHOZOAN, DIADUMENE LEUCOLENA (VERRILL). Clay Sassaman* and C. P. Mangum, Dept. of Biology, Col. of William and Mary, Williamsburg, Va. 23185.

Oxygen consumption rates for *D. leucopelta* to acclimated four temperatures from 10–27.5°C indicated thermal sensitivity throughout the temperature span. The Q₁₀ values for the ranges 10–17.5°, 17.5–22.5°, and 22.5–27.5° are 4.02, 2.97 and 1.40 respectively. Rates measured acutely on animals acclimated to 10° do not differ significantly from the acclimated rates although they tend to be slightly lower, indicating little or no thermal acclimation in this species.

Analysis of spontaneous contractions of the columnar muscles in whole animal preparations shows that activity (in mm contraction/hour) is also temperature sensitive in agreement with Van't Hoff Q₁₀ rule, as are the rates of muscle relaxation. It is suggested that this lack of energy-requiring compensatory mechanisms can be considered either an index of physiological simplicity or an energy-conserving adaptation to an environment where short term fluctuations of temperature are common. (Supported by NSF GB-6884 and GK-4185.)

SPATIAL DISTRIBUTION AND INTRA-POPULATIONAL MOVEMENT IN THE BULLFROG, *RANA CATESBEIANA*. M. Sebechich* and C. R. Brooks, Dept. of Biology, Col. of William and Mary, Williamsburg, Va. 23185.

A natural population of bullfrogs (*Rana catesbeiana*) was studied in a 2.3 acre pond during Apr.-Oct. 1968, in Williamsburg, Virginia. In September, other bullfrogs from neighboring ponds were introduced into the study area, and the subsequent spatial distribution, movement, and growth of both resident and foreign frogs were observed.

Habitat preference appeared to be the major factor affecting the nonrandom distribution of both the resident and foreign frogs around the shoreline. When introduced into the study ponds, foreign bullfrogs were subsequently recaptured in locations utilized by resident frogs. Two introduced frogs returned to their home ponds.

Centers of activity and "standard distance" were calculated for those bullfrogs captured 3 or more times. "Standard distance" of resident males were usually larger than those of resident females. Further, resident frogs had a significantly greater "standard distance" than did foreign frogs.

There was no distinct difference between growth rates of resident males and females. It appeared that growth of introduced frogs decreased or ceased as a result of having been transferred to a strange environment.

EFFECTS OF STRETCH AND TENSION ON CONDUCTION VELOCITIES AND THRESHOLDS IN A, B, AND C FIBERS IN THE SCIATIC NERVE OF THE FROG. N. H. Spector, Dept. of Physiology, Med. Col. of Va., Richmond, Va. 23219.

Whole, desheathed, sciatic nerves of the frog, *Rana catesbeiana* were subjected to stretch and tension. At tensions of approximately 1.0 to 3.5 grams, corresponding to elongations of about 9.4 to 13% above resting *in vivo* lengths, conduction velocities of A fibers increased significantly to maxima. Preliminary measurements showed similar changes for all groups of A, B, and C fibers. At higher degrees of stretch and tension, conduction velocity decreased and eventually (at approximately 13 grams tension, and 20% elongation) dropped below resting length levels. Changes were reversible well beyond the first inflection points. Preliminary studies with C fibers of *R. pipiens* sciatic nerves indicate a significant ($p < .01$) increase of velocity with a corresponding decrease in threshold, with maximum velocity of tension of approximately 1 gram, corresponding to elongation of about 12%. Similar increases were found in all groups (A, B, and C) with the possible exception of A-gomimo fibers. Maximum increases in velocity ranged from 20 to over 100%, depending upon the individual nerve and the group studied. These observations are discussed in terms of ionic flux theory and membrane models. Other possible explanations are examined.

THE WEIGHTS OF SELECTED ORGANS OF PRAIRIE DEERMICE (PEROMYCUS MANICULATUS BAIRDII) FROM ASYMPTOTIC LABORATORY POPULATIONS. C. Richard Terman, Dept. of Biology, Col. of William and Mary, Williamsburg, Virginia 23185.

The weights of the reproductive organs, bacula, adrenal glands, spleens, and thymus glands of deer mice from asymptotic laboratory populations were compared with controls kept as bisexual pairs. The testes, vesicular glands, ovaries, uterus, and bacula of population animals were significantly lighter in weight than those of controls. The weights of the adrenal glands and spleens exhibited no consistent differences between population animals and controls while the thymus exhibited weights inversely related to age and unrelated to the experimental situation. These data suggest that reproductive maturation and function are drastically inhibited in each population as a result of some attribute of density and that each population is an independent entity regulating its growth in response to stimuli which are intrinsically developed. Data from natural populations of *Peromyscus* are likewise indicative of effective population control mechanisms which have not been clarified.

EFFECT OF CHANGES IN OXYGEN AND CARBON DIOXIDE CONCENTRATIONS ON VENTILATION RHYTHMS IN POLYCHAETES. J. C. Tichy*, R. P. Dales*, and C. P. Mangum, Dept. of Biology, Col. of William and Mary, Williamsburg, Va. 23185 and Zoology Dept., Bedford Coll., Univ. of London, England.

Rhythmic bursts of ventilation activity in tubicolous polychaetes is believed to be governed by an endogenous pacemaker rather than a reflex feedback response to environmental variables. The present work was intended to elucidate effects of oxygen concentration, carbon dioxide concentration (pH), temperature and salinity.

At 25-50% oxygen saturation, two species show significant changes in parameters of ventilation, resulting in increased ventilation volume. At lower concentrations volume is greatly reduced, but rhythmicity is abolished. At pH 7.0-7.2 *Hyalinoeca rubicunda* shows temporary abolition of the pattern, but *Dipatira cuprea* maintains rhythmicity. *Hyalinoeca* shows little alteration in rhythm in response to temperature change until temperature approaches the lethal limit. Frequency of bursts of activity in *Dipatira* shows a predictable sensitivity to temperature.

The pattern of irrigation is modified but not abolished by changes of external variables. Sudden changes may temporarily disrupt the pattern, but return to a rhythmic pattern after acclimation supports the hypothesis of an endogenous pacemaker system.

THE GENUS VALERIANELLA IN VIRGINIA. Donna M. Eggers Ware, Dept. of Biology, Col. of William and Mary, Williamsburg, Va. 23185.

The weedy dicot genus *Valerianella* is represented in Virginia by three species: *V. locusta* (L.) Beteck, *V. radiata* (L.) Dufr., and *V. umbilicata* (Sull.) Wood. *Valerianella locusta* is a European introduction and is easily recognized by the blue-purple color of the limb of its small flowers and the coryn cap borne on the fertile locule of the fruit. The other two species are white-flowered and each is polymorphic with respect to fruit structure. Two of the four fruit morphs of *V. radiata* occur in Virginia--forma *radiata* and forma *fernaldii*, and two of the three fruit morphs of *V. umbilicata* are known from the state--forma *patellaris* and forma *intermedia*. These two species may be distinguished in the field by the size of their white flowers, those of *V. radiata* being less than 2.0 mm across and inconspicuous, while those of *V. umbilicata* are 3-5 mm across and showy. A fourth species, *Valerianella chenopodifolia* (Pursh) DC., known from West Virginia, may occur in our state flora, although I have not encountered it thus far in the course of this study.

EFFECT OF COMPETITION AND SOIL TYPE ON THE DISTRIBUTION OF TALINUM (PORTULACACEAE). Stewart Ware, Dept. of Biology, Col. of William and Mary, Williamsburg, Va. 23185.

Talinum calcaricum Ware is a succulent herb endemic to limestone outcrops of Tenn. and Ala., and the related *T. mengesii* Wolf is confined to sandstone and granite outcrops of Ala. and Ga. The two species sometimes grow on outcrops as close as 20 mi. apart, but they never occur on the same outcrop. On its respective outcrop type, each species is restricted to a very narrow ecotone between bare rock and deeper soil where other plants dominate. Tests of growth (dry wt.) of each species on both soil types with and without grass as a competitor revealed that *T. calcaricum* grew better without than with competition in both soil types. It grew better in limestone than in sandstone soil without competition, but grew so poorly when subjected to competition that soil type made no difference. In *T. mengesii*, inhibition by limestone soil was so pronounced that different responses to competition were not expressed. In sandstone soil it grew better without competition. The mutual exclusiveness in distribution of the two species is no doubt due to physiological intolerance of each species to the other's native soil type, and their distribution within outcrop vegetation must be due to poor competitive ability.

FUGITIVES AND ESTUARIES. Marvin L. Wass, Sch. of Marine Science, Col. of William and Mary, Dept. of Marine Science, Univ. of Va., Va. Inst. of Marine Science, Gloucester Point, Va. 23062.

The concept of the fugitive species, as given originally by G. Evelyn Hutchinson, is extended to include aspects of predation and disease, as well as competition, in determining the distribution of fugitives. Although Hutchinson proposed this concept 18 years ago, it has not found its way into general use.

Evidence is offered for considering estuaries as particularly favorable sites for the existence of fugitive species, organisms which often thrive under rigorous physical conditions but are less able to accommodate to biotic pressures. Some of these species are among the most economically valuable seafood sources.

Section of Chemistry

Forty-Seventh Annual Meeting of The Virginia Academy of Science
May 8-10, 1969, Fredericksburg, Virginia

POSITRON ANNIHILATION IN PROTON- AND GAMMA-IRRADIATED SODIUMCHLORIDE CRYSTALS*. Hans J. Ache and Thomas L. Williams, Dept. of Chemistry, Va. Polytechnic Inst., Blacksburg, Va. 24061.

The purpose of the present investigation was to assess the effect of point defects or vacancy centers on the annihilation process of positrons in sodium chloride crystals. A large number of defects was introduced by exposing the crystals to proton and gamma irradiation. Lifetimes and intensities of the various components observed in the annihilation spectrum were studied as a function of the number of crystal defects present.

HYDROGEN ISOTOPE EFFECTS IN 2,4-PENTHANE DIONE. A. L. Allred[†] and D. W. Thompson, Depts. of Chemistry, Northwest Univ. and Col. of William and Mary, Williamsburg, Va. 23185.

Isotope effects in acetylacetone were investigated by proton magnetic resonance, infrared spectroscopy, and ultraviolet spectroscopy. Partial substitution of deuterium at the terminal methyl groups and at the 3-position in the keto tautomer shifted the proton resonance peaks up-field. The change in the keto-enol tautomeric equilibrium resulting from deuterium substitution at the methylene carbon was measured at various temperatures. The enthalpy change for enolization of the protium-containing compound is more negative than for the deuterium-containing compound.

*Work supported by the U. S. Atomic Energy Commission.

SPECTROCHEMICAL ANALYSIS OF ANCIENT GREEK COINS.

Nancy F. Andrews^a and Bernard L. Mahoney. Department of Chemistry, Mary Washington College, Fredericksburg, Virginia 22401

A study was undertaken to explore the potential of atomic absorption analysis for characterizing ancient bronze coins. Gravimetric analysis of the major constituents of ancient coins gives the average composition for the coin, but involves either total or partial sample destruction. Samples were obtained from the surface of Greek bronze coins by controlled acid treatment without appreciable sample destruction, and analyzed by atomic absorption. Results compared favorably with data from gravimetric analysis of a chip sample from the same coin. X-ray fluorescence analysis, carried out on coins that had been electropolished, did not provide results that were consistent with either the gravimetric or atomic absorption data. The results from the analyses of several coins indicated that, with careful sampling techniques, atomic absorption analysis can provide accurate and representative information on ancient coin composition which can be useful in dating coins.

A COMPARISON OF THE SEMICARBAZONES AND THE THIOSEMICARBAZONES IN A MODIFIED WOLF-KISHNER REDUCTION. DANIEL W. ARMSTRONG*, JOSEPH B. PHILLIPS, III*, FREDRICK H. SANDS*, ROBERT T. SCHOOLEY*, JAMES K. SHILLINGTON AND ROGER L. YOUNG*, DEPARTMENT OF CHEMISTRY, WASHINGTON AND LEE UNIV.,LEXINGTON, VA. 24450.

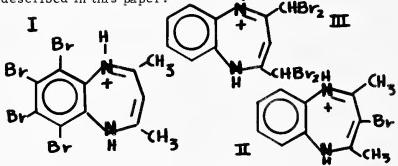
A comparative study of the advantages of semicarbazones and thiosemicarbazones as intermediates in a modified Huang-Minlon reduction of selected aldehydic and ketonic compounds to the corresponding hydrocarbons has been undertaken. The semicarbazone and thiosemicarbazone pairs of a variety of carbonylic compounds have been prepared and refluxed with strong alkali in high boiling solvents. The thiosemicarbazones have an original advantage of simply prepared, high-yield, high-purity derivatives but it would appear that reduction by way of the semicarbazones proper is the more satisfactory route. (Aided by Robert E. Lee Research Grants.)

ORGANOSILICON DERIVATIVES OF β -DIKETONES. P. G. Bowen* and D. W. Thompson, Dept. of Chemistry, Col. of William and Mary, Williamsburg, Va. 23185

The following 2,4-pentanedionato(acac)₂ complexes have been prepared: Cl₂Si(acac)₂, (C₆H₅)ClSi(acac)₂, (CH₃)₂Si(acac)₂, (CH₃)ClSi(acac)₂, and (C₆H₅)ClGe(acac)₂. Data are most consistent with these compounds having non-ionic, monomeric structures. Spectroscopic data suggest that the silicon complexes have symmetric *trans* structures whereas the germanium complex has the *cis* structure.

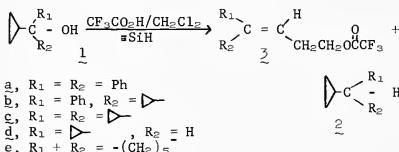
HETEROCYCLIC STUDIES: BROMINATION AND RE-ARRANGEMENT PRODUCTS OF 2,4-DIMETHYL (1,5)-BENZODIAZEPINE. J. Bradley* and R. L. Williams. Dept. of Chem., Old Dominion Col., Norfolk, Va. 23508.

The bromination of 2,4-dimethyl-(1,5)-benzodiazepine in acetic acid is reported to give the 6,7,8,9-tetrabromo (1,5)-benzodiazepinium hydrobromide(I) while bromination in carbon tetrachloride gives rise to the simple 3-bromo derivative (II). Recent studies in this laboratory require a reassignment of the tetrabromo product as the 2,3-dibromo-methyl (1,5)-benzodiazepium salt(III). Subsequent bromination of this system in glacial acetic acid brings about further electrophilic substitution and ring contraction to give a new heterocyclic ring system which will be described in this paper.



HYDRIDE TRANSFER TO CYCLOPROPYLMETHYL CATIONS. Francis A. Carey and Henry S. Tremper. Dept. of Chemistry, Univ. of Va., Charlottesville, Va. 22901

It was found that cyclopropylcarbinols 1-a-e are converted (mainly) to cyclopropylmethanes 2-a-e in methylene chloride-trifluoroacetic acid by hydride transfer from silanes.



The reactions are clean enough to be of synthetic utility and ring-opening is a problem only with 1a and 1b—probably because of steric destabilization of the arylcyclopropylmethyl cations.

SPECTROSCOPIC STUDIES OF BUTYLAMINE COMPLEXES. Wen Man Chang* and John C. Schug, Dept. of Chem., Va. Polytechnic Inst., Blacksburg, Va. 24061.

We are in the process of studying various complexes of n-butyl-, sec-butyl-, iso-butyl, and t-butylamine by means of proton magnetic resonance, infra-red, and ultraviolet-visible spectroscopy.

Dilute solutions of the amines with iodine in n-heptane provide typical examples of one-to-one charge-transfer complexes. By means of the standard Benesi-Hildebrand-type graphs, we have determined equilibrium coefficients for the charge-transfer bands as well as thermodynamic data for the several complexes. The effects of chain-branching was found to be rather small on these quantities.

Proton chemical shift data obtained from necessarily more concentrated solutions of the amines in various media, are more difficult to interpret. Data from amine-hexane solution provided information on the self-association of the amines. When iodine is added to pure amine, or to amine-dioxane mixtures, however, the resulting chemical shifts indicate that the apparent equilibrium constants vary with the compositions, even when the iodine content is only one-tenth mole-fraction. Data from iodine solutions in pure amine can be interpreted in terms of either one-to-one or two-to-one amine-iodine complexes. (Aided by NSF Grant No. GP-5471).

ORGANIC REACTIONS IN FUSED SALTS. T. I. Crowell, L. L. Burton and P. Hillery. Dept. of Chemistry, Univ. of Va., Charlottesville, Va. 22901

Some organic compounds, especially polyhydroxy compounds, are soluble in fused salts. We have investigated reactions in two of these novel solvents.

In fused Li-Na-K acetate eutectic, a basic solvent, aromatic amine indicators are ionized and the hydrogen atoms on the methyl groups of the acetate ions are slowly exchanged. Triols of the type $\text{RC}(\text{CH}_2\text{OH})_3$ react quantitatively to form $\text{CH}_2=\text{CROHCO}$, CH_2OH and H_2O , for which a mechanism involving base catalysis is proposed.

Molten KSCN is a nucleophilic medium in which displacement reactions are being studied. The kinetics of the Wöhler rearrangement of anilinium thiocyanate to phenyl thiourea have been studied over the entire concentration range, dilute solution to anhydrous fused salt. The rate seems to undergo no abrupt change as the last water is removed from solution.

A MOLECULAR MODEL OF AGING AND SENESCENCE. I Gordon Fels. Division of Biochemistry, Virginia Institute for Scientific Research, Richmond, Va. 23226.

The "survival" of stretched rubber bands is found to exhibit senescence characteristic of biological populations. The elements of a senescent system are described as an energy requiring displacing force, a counter-acting retroactive force and a spontaneous reaction altering the structure of a component in the system.

For Gompertz kinetics to be obeyed, the latter reaction is limited to those whose kinetics are a function of e^t . These are free radical oxidation, molecular ordering and inorganic crystallization.

STUDIES ON α -HYDROXYMETHYLKETONES. Leif S. Gausdal and Oscar R. Rodig, Depts. of Chemistry, Univ. of Oslo and Univ. of Va., Charlottesville, Va. 22903

When a crossed Aldol condensation was carried out with ketones and paraformaldehyde or trioxane under strongly acidic conditions methylene ethers of a unique structure were produced, which could be converted to branched sugar-like compounds (ketoses). Ketoacids gave similar lactone type structures. For example, from levulinic acid the 3,5,5-trimethylolhydroxypicolinic acid lactone was obtained. The α -hydroxymethyl group of these products were found to be labile and "transhydroxymethylolation" could be carried out. In the presence of formaldehyde the ketomethylene ethers could be further reduced to the corresponding alcohols. Mass spectral and nuclear magnetic resonance data of the methylene ethers show characteristic patterns and may be of diagnostic value.

MÖSSBAUER SPECTRAL STUDIES OF SOME TIN(II) COMPLEXES. Dean C. Featherston² and John F. Lefelholz*, Dept. of Chem. and Pharm. Chem., Virginia Commonwealth University, Richmond, Va. 23219

Tin(II) alkoxides of various alcohols have been prepared. Liquid nitrogen temperature spectra of all of the compounds exhibited quadrupole splitting. The quadrupole splitting values are among the largest values observed for tin(II) compounds. The isomer shift values ranged between 2.69–2.96 mm/sec versus the maslon source. A correlation of the isomer shifts and quadrupole splittings shows that the alkoxide ions exert strong crystal field effects, causing the two non-bonding electrons of tin to be distributed in its $5s$ and in only one of its $5p$ orbitals. As the molecular weight of the alkoxide ion increases the values of the isomer shifts increase, indicating that the methoxide ion forms the strongest tin alkoxide bond. A comparison of the isomer shifts for the tin alkoxides with that observed for SnCl_2 in alcohol glasses reveals that of the alcohols, methanol will have the strongest O-H bond and the increasing order of alcohol acidity will be methyl < ethyl < propyl.

RING-CHAIN TAUTOMERISM OF 2,5-DIARYL-2-HYDROXY-3-FURANONE SYSTEMS. SOLVENT AND SUBSTITUENT EFFECTS. P.R. Flippin* and R.G. Bass, Department of Chemistry, Virginia Commonwealth University, Richmond, Virginia 23220

A series of para substituted diarylethenols have been prepared by the action of anhydrous HCl on the corresponding diarylethylen oxide in benzene. By instrumental techniques, it has been shown that these substances exist as the chelated form of 1,4-diaryl-1,2,4-trione enol in chloroform whereas in dimethylsulfoxide the ring-chain tautomer, 2,5-diaryl-2-hydroxy-3-furanone, predominates. In mixtures of the two solvents, nm studies indicate that a solvent dependent equilibrium exists between the hydroxyfuranone and the tautomeric open chain chelated enol. Using 80% DCCl_3 – 20% DMSO-d_6 as solvent, the effect of substituents on the furanone-enol ratio has been measured and it was observed that the percent furanone increases as the electron withdrawing capacity of the substituent group increases. A Hammett plot gives a straight line with a positive slope indicating that cyclization to the furanone form is facilitated by the presence of electron withdrawing groups.

The preparation of 1,2-di(2-chloro-5-methylbenzoyl) ethenol has been repeated and a solid furanone form as well as a solid chelated enol form have been characterized instrumentally, confirming the structural assignments proposed by Lutz and Boyer. A solvent dependent equilibrium between the enol and its ring-chain tautomer was also demonstrated for this substance.

ANTIMALARIALS: 8-QUINOLINEMETHANOLS. J. S. Gillespie, Jr., B. K. Barnes*, S. P. Acharya*, and R. E. Davis*. Va. Inst. for Scientific Res., Richmond, Va. 23226

A series of 8-quinolinemethanols has been synthesized for evaluation as antimalarial compounds. Little prior work on these compounds has been reported, only 5 examples appearing in the literature to date.

First synthetic trials followed the well-known pathway from the carboxylic acid through the acid chloride and other intermediates to the aminomethanol. The scheme failed because the 8-quinoliniccarboxylic acids studied did not react to form acid chlorides. Two alternate pathways were developed. When nuclear alkyl substitution was not required in the final compound, the aldehyde was made by SeO_2 oxidation of the 8-methylquinoline. If alkyl substitution was required, the aldehyde was prepared from the 8-quinoliniccarboxylic acid by LiAlD_4 reduction of the ester and $\text{DMSO-pyridine-SO}_2$ oxidation of the alcohol. Oxiranes were made by reaction of the aldehydes with dimethylsulfonium methylide, and the aminomethanols were obtained by condensation of the oxirane with suitable secondary amines.

Incomplete biological evaluation indicates that certain substituted 8-quinolinemethanols have moderate activity vs. *P. berghei* in mice. The activity is much less than that of the isomeric 4-quinolinemethanols. (Supported by US Army Medical Research and Development Command.)

USE OF INTEGRATION READOUT TECHNIQUES FOR LOW ABSORBANCE SAMPLES IN ATOMIC ABSORPTION SPECTROSCOPY. W. W. Harrison and F. E. Berry*. Dept. of Chemistry, Univ. of Va. Charlottesville, Va. 22901

Analog integration of noise laden information signals from an atomic absorption spectrometer is shown, using chopper stabilized and FET input operational amplifiers. The averaging tendency of the random noise along with the linear accumulation of the unidirectional absorption signal produces a sharp increase in net signal-to-noise ratio. Reproducibility and working curves are shown for magnesium and copper solutions which absorb in the 0-4% range. Detection limits are lowered and analytical working conditions are shown for magnesium in the low parts-per-billion range. Critical parameters affecting integration are indicated.

THE ISOLATION AND CHARACTERIZATION OF A HYDROCELLULASE FROM TRICHODERMA VIRIDE. T. H. Liu* and R. D. Brown, Jr. Dept. of Biochemistry and Nutrition, Va. Polytechnic Inst., Blacksburg, Va. 24061

A hydrocellulase from *T. viride* was purified by differential adsorption on Avicel, ammonium sulfate fractionation and DEAE-Sephadex column chromatography. Its activity toward insoluble hydrocellulose was increased tenfold when C_x enzyme, another component of the multi-enzyme cellulase system, was added. The hydrocellulase showed little activity toward carboxymethylcellulose or p-nitrophenyl-p-D-glucoside.

The purified enzyme was homogeneous as shown by both analytical ultracentrifugation and polyacrylamide gel disc electrophoresis. Its sedimentation coefficient is 3.8 S, and its molecular weight as determined by equilibrium centrifugation is about 44,000. It contains ten percent carbohydrate and is rich in acidic and hydroxylated amino acids.

THE KINETICS OF BROMINE OXIDATION OF 2-PROPANOL. THE PARTICIPATION OF TRIBROMIDE ION. John G. Mason and L. G. Baird. Dept. of Chemistry, Va. Polytechnic Inst., Blacksburg, Va. 24061.

The oxidation of isopropanol by electrolytically generated Br₂ in aqueous sulfuric acid-NaBr solutions has been found to have the rate law

$$\frac{-d(Br_2)_t}{dt} = \left[\frac{k_1 + k_2 (Br^-)}{1 + K (Br^-)} \right] [ROH][Br_2]_t$$

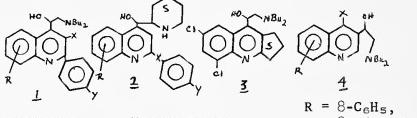
The rate constant k₁ is attributed to a path involving Br₂; k₂ is attributed to a reaction path involving Br₃⁻. In solutions of low acidity no Br₃⁻ path appears in agreement with previous literature. The confirmation of the form of the rate law and the establishment of K as the formation constant of the tribromide ion was established by independent measurement of K. (Work done under VPI NASA Multidisciplinary Grant 47-004-006)

KINETIC STUDY OF THE CORROSION OF ALUMINUM IN THE PRESENCE OF MERCURY. James F. Kusterer and H. Lee Craig, Jr. Dept. of Chemistry, Virginia Commonwealth Univ., Richmond, Va. 23220

The mechanism of aluminum corrosion was investigated in the presence of mercuric iodide. Hydrated Al₂O₃ whiskers are the rapidly grown corrosion product. Using thermal gravimetric analysis weight gain data was collected under atmospheres containing varying O₂ and H₂O vapor concentrations. Corrosion rates were determined at four temperatures from 20 to 50°C. Decomposition of the reagent occurs under these conditions at higher temperatures. The values ranged from 0.03% to 0.325 mg/cm²/min (MCM). Activation energy was 6.17 kcal/mole. Rate data obtained at 30°C compared favorably with that obtained by previous workers using another method. In the absence of H₂O vapor, the rate was 0.001 MCM. As the relative humidity (RH) was increased from 15 to 100% the rate increased from 0.003% to 0.098 MCM. The dependence followed an S-shaped curve, with an increasing rate below 65% RH and a decreasing rate above that value. This also closely paralleled the previous data. Then O₂ was diluted with N₂ and the rates ranged from 0.052 MCM for a 10% O₂ up to 0.098 MCM for the 100% O₂ atmosphere. The rate was proportional to the log of the O₂ concentration, which suggested a first order reaction rate dependence. The activation energy value suggested that the rate controlling step involves the adsorption of water onto the aluminum amalgam, and the O₂ concentration dependence suggests that the adsorption of O₂ onto the adsorbate layer is also a critical, rate controlling step.

SYNTHESIS OF 3- AND 4-QUINOLINE α -DIALKYLAMINO-METHYL METHANOLS AS POTENTIAL ANTIMALARIALS. R. E. Lutz, F. C. Davis*, R. E. Johnson*, H. R. Munson, Jr.*; C. J. Ohnmacht, Jr.*; A. R. Patel*, J. R. Shanklin, Jr.*; J. M. Sanders* and R. R. Wetzel*. Dept. of Chemistry, Univ. of Va., Charlottesville, Va. 22901

Procedures are described for syntheses of 23 new potential antimalarials of types 1-4. Most of those tested to date were active or curative against *Plasmodium berghei* in mice.



R = 8-C₆H₅,
R = H or X = O or NH; 8-CF₃, 7-6,8-di-Cl; R = H, 6-CH₃, 6-Cl, Cl, 6,8-di-CH₃, X = Cl or Br; or 6,8-di-CH₃; or 6,8-di-Cl; Y = H or Cl. Y = CH₃, Cl, SCH₃. X = Cl or H.

(Supported by WRAIR Contract DA-22-193-MD-2955)

MAGNETIC CIRCULAR DICHROISM OF IrCl₆²⁻ IN CRYSTALLINE (CH₃NH₂)₂SnCl₆. A. J. McCaffery*, P. N. Schatz, and T. E. Lester*. Dept. of Chemistry, Univ. of Virginia, Charlottesville, Va. 22901

The magnetic circular dichroism (MCD) of IrCl₆²⁻ doped into crystalline (CH₃NH₂)₂SnCl₆ has been studied from liquid helium to room temperature over the spectral region 6000-3000 Å. The results confirm the new assignment (based on solution MCD data) which places the ²T_{1g} charge-transfer state at lower energy than the corresponding ²E_g state. The spin-orbit splitting of the ²T_{1g} state which is not apparent in the absorption spectrum or solution MCD shows up strikingly in the crystal MCD illustrating the potentialities of such studies particularly at low temperatures. The approximate 1/T variation in the MCD from room temperature to 6° shows conclusively that the allowed charge-transfer bands in MCD arise primarily from C terms and is the first experimental demonstration over a very wide range of temperature of this theoretically expected temperature dependence. There is no indication of antiferromagnetic coupling, at least down to 6°K.

USE OF HELIUM IONIZATION DETECTOR FOR AIR POLLUTION STUDIES.
H. M. McNair, Dept. of Chemistry, Va. Polytechnic Inst.,
Blacksburg, Va. 24061

Helium can be raised to a metastable state with small background due to ionization. This metastable state has a reasonable lifetime, and sufficient energy (19.8 eV) to ionize all other molecules except neon with high efficiency. When used as a gas chromatographic detector it can detect parts per billion of fixed gases and light hydrocarbons. The problems arise from the need for ultra-pure helium, normal contamination of injection septums, tubing and vapor pressure of organic liquid phases.

If solid adsorbents and porous polymer columns are used, a reasonable baseline is obtained and trace parts per million of many air pollutants is possible. We have been unable to go below 40 ppm SO₂ because of adsorption effects, primarily on the column. It is possible that concentration of trace quantities on a chromatographic column which first serves as the concentrator, and later as a separator may enable even parts per billion analysis.

AN ORGANIC COLLOQUIUM. S. B. Monroe. Dept. of Chemistry, Randolph-Macon Col., Ashland, Va. 23005.

The four-one-four academic year, consisting of two four-month semesters, separated by a one-month colloquy period, presents an excellent opportunity to introduce a stimulating laboratory program in the undergraduate chemistry curriculum. At Randolph-Macon, a colloquy entitled "Research Techniques in Organic Chemistry" is offered during the middle term. In addition to providing the student with an understanding of the essentials of organic chemical research, a primary objective of this course is to arouse an enthusiasm for laboratory work which can be derived only through participation in a research-like enterprise. Assignments include library research, elucidation of chemical structures, using chemical and spectroscopic techniques, and multistep syntheses. Since a student is enrolled in only one colloquy, he is not involved with any other course work which might make demands on his time or distract his attention. Rather, he is allowed to spend virtually full time in the performance of laboratory work for a period of several weeks.

PREPARATION AND ANTIBIOTIC PROPERTIES OF SOME 5', 7'-DIHYDROXYFLAVANONES. David A. Nash, Jr.* and Samuel J. Gamble, Department of Chemistry, Lynchburg College, Lynchburg, Va. 24504

A modified Aldol type reaction has been used to synthesize 5',7'-dihydroxyflavanone, 5',7'-dihydroxy-4-methoxyflavanone, and 5,7'-dihydroxy-4-ethoxyflavanone. This series of compounds was examined for antibiotic properties against *Bacillus subtilis* as a test organism.

THERMAL DECOMPOSITION OF SOME POTASSIUM XANTHATE SALTS. Raphael M. Ottenbrite and Kenneth G. Rutherford*. Dept. of Chemistry, Virginia Commonwealth University, Richmond, Va. 23220

The pyrolysis of S-methyl xanthate esters to produce olefins has been well documented as a synthetic procedure. It was decided to study the pyrolysis of the corresponding potassium xanthate salt intermediates. The pyrolysis of several xanthate salts of tertiary alcohols were conducted and olefin products were obtained. In each case, the product distribution was very similar to that obtained on pyrolysis of the corresponding xanthate ester. The overall yields of olefin from these xanthate salts were increased by 10-30 % over those obtained from the corresponding xanthate esters. The pyrolysis of potassium xanthate salts of primary and secondary alcohols, however, yielded a mixture of olefin(s) and starting alcohol.

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COORDINATION COMPOUNDS OF URANIUM AND PLUTONIUM. D.L. Plymale, Monsanto Research Corporation, Miamisburg, Ohio and Dept. of Chemistry, Roanoke Col., Salem, Va. 24153

In an attempt to prepare stable compounds of plutonium for possible use as standards, we have investigated several plutonium and uranium coordination compounds. Relatively few coordination compounds of plutonium have been reported. In this report the preparation and characterization of compounds, with propylene (2-hydroxy-2,4,6-cycloheptatrien-1-one), triphenylarsine oxide and tri-phenylphosphine oxide are discussed. Infrared data have been used to characterize these compounds.

MATRIX EFFECTS IN THE ATOMIC ABSORPTION ANALYSIS OF TRACE ELEMENTS IN SERUM. Marilyn L. Shull* and Bernard L. Mahoney. Department of Chemistry, Mary Washington College, Fredericksburg, Virginia. 22401

The matrix effect in the analysis of Cu, Fe, and Zn in serum by atomic absorption has been investigated. In the direct analysis of untreated serum using synthetic standards, both the inorganic matrix and the viscosity produce a marked decrease in the absorption of Cu, Fe, and Zn. With a 1:1 dilution the inorganic matrix effect is eliminated for Cu and Fe, but it still exists to a lesser degree for Zn. The viscosity effect, although not as significant as in the direct analysis, is still present upon dilution. If synthetic standards are carefully prepared to compensate for interelement and viscosity effects, the analysis of Cu, Fe, and Zn by a simple dilution method will provide sensitive, precise, and more rapid results compared to methods involving pretreatment of the sample for removal of interferences. The results of random serum analyses of hospital patients and controls by a dilution method are presented.

KINETIC STUDIES OF THE THERMAL DECOMPOSITION OF NITRO-ORGANIC COMPOUNDS. B. D. Smith, Advanced Systems Department, Naval Weapons Laboratory, Dahlgren, Virginia 22448

Differential Thermal Analysis (DTA), Thermogravimetric Analysis (TGA) and Differential Scanning Calorimetric (DSC) techniques together with several kinetic models and data reduction procedures have been used to study the slow thermal decomposition of 1,3,5-trinitro-1,3,5-triazaacyclohexane and 1,3,5,7-tetrinitro-1,3,5,7-tetraazaacyclooctane. The calculated values for the activation energy and frequency factor show reasonable agreement with previous studies.

A MICRO-ADSORPTION DETECTOR FOR LIQUID CHROMATOGRAPHIC STUDIES. D.T. Stafford*, and H.M. McNair, Dept. of Chemistry, Va. Polytechnic Inst., Blacksburg, Va. 24061

Until now, gas chromatography has proven far more useful than liquid chromatography as an analytical technique. Liquid chromatography, while the older method has been primarily a preparative technique. The use of high pressure flow systems, and sensitive low dead volume detectors is rapidly changing this situation.

A commercially available Micro-Adsorption Detector is described. It is found to be quite sensitive and to have a dead volume of less than 10 microliters. The peak shapes obtained however are not familiar ones, and in some cases a negative desorption peak may interfere with a positive adsorption peak. It appears feasible to study heats of adsorption, heats of solutions and even heats of reactions by means of this detector.

A KINETIC STUDY OF THE HOMOGENEOUS HYDROGENATION OF OLEFINS AND ACETYLENES. B. L. Stump* and Henry P. Lau*, Dept. of Chem. and Pharm. Chem., Va. Commonwealth Univ., Richmond, Va. 23219

The use of certain coordination complexes of the transition metals, especially those in the platinum groups, to catalyze the addition of molecular hydrogen to unsaturated hydrocarbons in homogeneous systems has been reported recently. Chloratris(triphenylphosphine) rhodium(I) is especially effective as a catalyst (J.A. Osborn, F.H. Jordine, J.F. Young, and G. Wilkinson, *J. Chem. Soc. (A)*, 1711 (1968) but the investigations which have been reported were made using hydrogen at pressures of less than one atmosphere.

Studies employing this catalyst have been extended to hydrogenation reactions in the low-pressure Parr system. The hydrogenations of 2-butene-1,4-dial and cis-2-butene-1,4-dial have been found to be first-order in hydrogen pressure between 35 - 50 psig and zero-order in substrate when about 6(10^{-3}) moles of substrate to 6(10^{-5}) moles of catalyst (100 to 1 ratio) was used. These kinetics parallel those found for the hydrogenation of organic substrates over heterogeneous catalysts in the Parr system. The temperature dependence of the rate of hydrogenation has been investigated and enthalpies and entropies of activation for the two compounds calculated.

PHOTOCHEMICAL DEOXYGENATION OF AROMATIC NITRO COMPOUNDS. R. J. Sundberg, B. P. Das*, and R. H. Smith, Jr.* Dept. of Chemistry, Univ. of Va., Charlottesville, Va. 22901

Nitrobenzene and substituted nitrobenzenes are deoxygenated at 30 \pm 5° when irradiated in triethyl phosphite solution. Triethyl phosphite is oxidized to triethyl phosphate and the nitro compound is converted to the corresponding triethyl N-aryl-phosphorimidate and to the aniline. When the nitrobenzene is substituted with an o-alkyl group, rearranged products containing the pyridine ring are formed. The mechanism of these transformations will be discussed in terms of aryl nitrene intermediates. The presence of acetic acid in the reaction medium profoundly alters the product distribution and leads to formation of o-hydroxyacetanilides and diethyl aminophenylphosphonates. Structural characterization of these products and their mode of formation will be discussed.

STEREOCHEMICAL CHARACTERIZATION OF SOME PIPERIDINE-4-ACETIC ACID DERIVATIVES. R. J. Sundberg and F. O. Holcombe, Jr.* Dept. of Chemistry, Univ. of Va., Charlottesville, Va. 22901

Ethyl 1-benzoyl-3-ethyl- Δ^1 , Δ^2 -piperidineacetate (1) and ethyl 1-benzoyl-3-ethyl-1,2,3,6-tetrahydropyridine-4-acetate (2) have been prepared from 1-benzoyl-3-ethyl-4-piperidone by the phosphonate modification of the Wittig reaction. Compound 1 is isomerized to 2 by base. Catalytic reduction of 1 gives mainly ethyl cis-1-benzoyl-3-ethyl-4-piperidineacetate while 2 gives mainly the trans isomer. The stereochemical correlation of these compounds and several other synthetic 4-piperidineacetic acid derivatives with cinchonine via the trimethylsilyl derivative of 1-methyl-3-ethyl-4-piperidine-ethanol will be described.

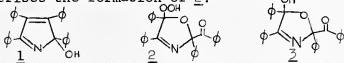


THE BIOSYNTHESIS OF MOLD METABOLITES. Robert J. Sysko and Oscar R. Rodig, Dept. of Chemistry, Univ. of Va., Charlottesville, Va. 22903

Radioactive tracer methods have been applied to study the biogenesis of citrinin, a mold metabolite and antibiotic, by *Penicillium citrinum*. The biogenesis appears to be characterized by two distinct metabolic phases: a tropophase, beginning at inoculation and lasting 15-20 days, during which time glucose is catabolized via the Pentose Phosphate pathway and cell material is built up; and an idiosyncratic phase, lasting through days 21-30 when glucose is catabolized via the Embden-Meyerhof pathway and citrinin is biosynthesized. The addition of exogenous metabolite to growing cultures of the mold decreases the yield of antibiotic isolated, suggesting the operation of an inhibitory feedback mechanism. Incorporation studies with ^{14}C labeled methyl dihydrocitrinone diacetate, methyl dihydrocitrinone, triacetic acid lactone, and dihydrocitrinone have demonstrated that the final step in the biosynthesis most likely involves the oxidation of dihydrocitrinone to citrinin. For the incorporation work, the proposed labeled intermediates were prepared by chemical synthesis from radioactive citrinin.

THE OZONIZATION OF 2,3,4,5-TETRAPHENYL PYRROLE.
C. R. Taylor, Jr.*[†], D. W. Boykin, Jr.* and R. E.
Lutz, Dept. of Chemistry, Univ. of Va.
Charlottesville, Va. 22901

The ozonization of 2,3,4,5-tetraphenylpyrrole in chloroform at 0° has been shown to give in good yield, not the expected 2-hydroxyppyrrolenine 1, but the hydroperoxide 2. The 2-hydroxyppyrrolenine 1, has been shown to be an intermediate by independent synthesis and subsequent ozonolysis to 2. Acidic or basic hydrolysis and pyrolysis of 2 gave one mole of benzil. Reducing agents such as potassium iodide, triphenylphosphine, and surprisingly, dimethylsulfoxide, gave the corresponding alcohol 3, which upon hydrolysis in acidic media gave two moles of benzil. The proposed structure of the hydroperoxide 2 is consistent with the products from the reduction and hydrolysis reactions, and the IR, NMR, and mass spectral data. A mechanism of the ozonization is discussed which describes the formation of 2.



COPPER(II) AND NICKEL(II) COMPLEXES OF BIS(2-AMINOETHYL)SULFIDE. L. T. Taylor, Dept. of Chemistry, Va. Polytechnic Inst., Blacksburg, Va. 24061 and E. K. Barefield*, Dept. of Chemistry, Ohio State Univ., Columbus, Ohio 43210

Nickel(II) and copper(II) complexes of bis(2-aminoethyl)sulfide have been prepared and characterized. Magnetic, spectral and conductivity data indicate that the copper complexes are probably five coordinate whereas the nickel complexes are six coordinate pseudo-octahedral structures. A *trans* facial configuration is postulated for the bis nickel complexes based on a study of stereo-models as well as the observation of strong tetragonal distortion from octahedral symmetry in the electronic spectra at room and liquid nitrogen temperatures. The ligand exerts a medium strong ligand field, having $Dq_{XY} = 1172 \text{ cm}^{-1}$ and $Dq^Z = 970 \text{ cm}^{-1}$.

SELECTIVE ALKYLATIONS OF PHENYLACETYLUREA THROUGH ITS 1,3,5-TRIANION. Jack D. Taylor* and James F. Wolfe, Department of Chemistry, Virginia Polytechnic Institute, Blacksburg, Virginia 24061.

In connection with a continuing study of the chemistry of multiple anions, it has been found that phenylacetylurea (I) can be converted to its 1,3,5-trianion (II) by means of alkali amides in liquid ammonia.



Treatment of trianion II with alkyl halides affords products resulting from selective C-alkylation with apparently complete exclusion of N-alkyl derivatives. These alkylations are dependent on the nature and molar quantities of the alkali amide used to generate II. Reaction of trianion II with alkyl halides provides a convenient new route to C-alkyl phenylacetylureas, a class of compounds known to have anticonvulsant activity. (Supported by NIH Grant GM 14340).

AUTOXIDATION OF POLYUNSATURATED METHYL ESTERS IN THE PRESENCE OF NITROGEN DIOXIDE. Susan J. Webster* and Lawrence A. Wishner, Department of Chemistry, Mary Washington College, Fredericksburg, Virginia 22401

Nitrogen dioxide, considered one of the most active compounds contributing to atmospheric smog, has been reported to promote the "peroxidation" of lung lipids in rats exposed to as little as 1 ppm for only a few hours. In order to investigate the ability of NO₂ to initiate autoxidation, the length of the induction period and the rate of O₂ absorption from air by methyl linoleate and methyl linolenate in the presence of 80 ppm NO₂ were observed manometrically. Measurements were carried out on pure methyl esters and buffered emulsions (pH 7.2) in both the presence and absence of α -tocopherol, the naturally occurring antioxidant of tissues.

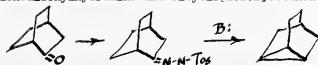
Nitrogen dioxide significantly accelerated O₂ absorption by pure methyl linoleate. The failure of α -tocopherol to inhibit this process suggests that it is not a radical-initiated autoxidation. On the other hand, NO₂ inhibited O₂ absorption by buffered emulsions of methyl linoleate and α -tocopherol appeared to enhance this inhibition, suggesting a radical-initiated autoxidation with NO₂ acting as an antioxidant by intercepting free radicals. The behavior of methyl linolenate was inconclusive.

A DOUBLE OCTANT OR DECAHEXANT RULE FOR PLANAR TRANSITION METAL ION COMPLEXES OF AMINO ACIDS AND PEPTIDES. Edmund W. Wilson, Jr.* and R. Bruce Martin. Dept. of Chemistry, Univ. of Va., Charlottesville, Va. 22901.

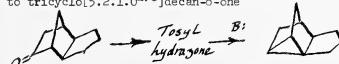
Divalent copper and palladium ions form planar complexes with amino acids and dipeptides. Both of these metal ions and nickel ion form square planar complexes with tripeptides. When all amide hydrogens have been ionized in the peptide complexes relatively rigid structures are indicated with specific side chain dispositions. Cotton effects observed in the ligand field bands of the metal ions for dipeptide complexes M(X-X) may be predicted by adding the results for M(gly-X) and M(X-gly) where gly represents a glycyl and X an L- or D- amino acid residue. These results cannot be accounted for by any simple octant rule. A double octant rule accounts for the magnitude additivity observed in these complexes. In the double octant the coordination plane about the metal ion is divided perpendicularly into eight sectors of alternating sign centering on the metal ion. Side chains of L-amino acid residues of planar metal ion complexes of di- and tripeptides all fall into double octants of identical sign, accounting for the results.

BICYCLOCOTANONE DERIVATIVES II. G. S. WHITNEY AND SEAN O'CONNOR, DEPT. OF CHEMISTRY, WASHINGTON AND LEE UNIVERSITY, LEXINGTON, VA. 24450.

Chemists have found that treatment of p-toluenesulfonylhydrazones with base gives rise to carbenes which can undergo insertion at nearby $\alpha\beta$ -C=C-. Thus, the product of p-toluenesulfonylhydrazine and bicyclo[2.2.2]octane-2,



when treated with sodium in acetamide gives tricyclo [2.2.2.0^{2,6}] octane. We have extended this type of reaction to tricyclo[5.2.1.0^{2,6}]decan-8-one



in hopes of creating some new hydrocarbons with cyclopropane rings.

THE CRYSTAL STRUCTURE OF URONIUM NITRATE (UREA NITRATE) BY NEUTRON DIFFRACTION. J.E.Worsham, Jr., Chemistry Dept., University of Richmond, Va., 23173 and William R. Busing, Chemistry Division, Oak Ridge National Lab., Oak Ridge, Tenn.

Urea, as well as other amides, forms acid salts. The position of the acidic proton in urea nitrate was sought in order to help understand the nature of this basicity of amides. Finding the proton on the carbonyl atom of urea led to the change in name from urea nitrate to uronium nitrate. This same site for the acidic proton has been found in acetamide hemihydrochloride and suggests that in amides the carbonyl oxygen is generally the source of their basicity.

Uronium nitrate, $(\text{NH}_2)_2\text{CO}\text{NH}_3^+$, crystallizes with symmetry $\text{P}2_1/c$ and lattice parameters $a = 9.543(6)\text{\AA}$, $b = 8.2010(5)\text{\AA}$, $c = 7.4982(4)\text{\AA}$ and $\beta = 124.246(6)^\circ$. The crystal structure, determined from 17/44 independent experimental neutron diffraction intensities, shows a layer arrangement with all atoms approximately at $z = 1/4$ or $3/4$. The acidic proton is on the carbonyl oxygen atom with an O-H distance of $1.006(3)\text{\AA}$ and forms a hydrogen bond to a nitrate oxygen atom with an O-H...O distance of $2.596(2)\text{\AA}$. Four other hydrogen bonds of the type N-H...O join the uronium and nitrate ions into a two-dimensional network. The only contacts between the layers are of van der Waals type. The C-O distance, $1.298(2)\text{\AA}$, and the C-N distance, $1.312(1)\text{\AA}$ and $1.315(1)\text{\AA}$, are longer and shorter, respectively, than the corresponding distances in urea.

Section of Engineering

Forty-Seventh Annual Meeting of The Virginia Academy of Science
May 8-10, 1969, Fredericksburg, Virginia

FORCES ARISING FROM THE INTERACTION OF A JET WITH A SPHERICAL OBJECT. P. S. Barna, Sch. of Engineering, Old Dominion College, Norfolk, Va. 23508

Forces arising from the interaction of an air jet with a solid spherical object were experimentally investigated. In these tests the diameter of the object was substantially larger than the diameter of the jet issuing from an orifice-nozzle. The main variable was the displacement distance between the center of the object and the axis of the jet and a variable parameter was the range distance between the orifice and the object. In each test run the range distance was kept constant and the displacement distance was varied. The test results indicate that the forces arising from the interaction are similar to those experienced on a wing. Accordingly, lift and drag forces were found to first increase, attain a maximum then decrease with increasing displacement. In addition to direct force measurements, pressure distribution for a specific range distance was also recorded. (Aided by O.D.C. Educational Foundation).

A MATHEMATICAL MODEL OF A NYLON 6 CONTINUOUS POLYMERIZATION PROCESS. Dr. S. C. Chu, and I. C. Twilley. Allied Chemical Corp., P.O. Box 31, Petersburg, Va. 23803

This paper describes the development, structure, and construction of computerized mathematical model for the hydrolytically-initiated nylon 6 polymerization process. The model incorporates chemical kinetics equations and includes mass transfer and flow dynamics considerations.

The program is capable of handling both acid-terminated and unterminated polymerization. Examples of its application in process design, process behavior prediction and process optimization are presented.

A graphic illustration of this relatively new approach is described. Not only does this technique considerably reduce the need for experimental verification of process variable effects, but it also drastically reduces the time lag between process design and commissioning of the commercial facility.

ENGINEERING IN RECREATION EQUIPMENT. Ralph Davis, Jr.*
Brunswick Corporation, Marion, Virginia 24354

Recreational equipment derivations are reviewed and the evolution to today's emergent game simulators is traced.

A description of the engineering elements and principles in a sophisticated golf simulator is presented. Other simulated equipment is described including a less sophisticated golf game, and an archery game.

Up to date status of the forthcoming automatic bowling scorer with description of its mode of operation is also presented.

CLOUD CONDITIONING WITH HIGH VELOCITY SMALL DUCT SYSTEMS. J. J. Dieckmann, Space Conditioning Div., Dunham-Bush, Inc. Harrisonburg, Va. 22801

Design parameters of a unique, new complete central air conditioning (cooling) system designed for simplified installation, quiet operation and total comfort are compared to a conventional system. A 2" I.D. small duct distribution system with lower air flow, cooler air and higher velocities is shown to give significantly greater dehumidification (higher latent capacity) leading to greater comfort at the same temperatures.

Through use of "Effective Temperature" as developed by ASHRAE it is shown that comfort in living space can be maintained using the new system developing less total cooling capacity as rated by accepted industry (ARI) Standards. A term "Effective Capacity" is developed to relate to equivalent effective temperatures for same comfort sensations in the living space, permitting system designers to use conventional factors for equipment sizing.

Omission of reheat to provide year round comfort is discussed. Inherent advantages of very rapid installation of prefabricated, fast-connect small duct system are highlighted along with further comfort advantage of excellent air circulation effected by high velocity jets discharging into the room.

THE REMOVAL OF TEXTILE DYE WASTES BY FOAM FRACTIONATION. T. Fansler and D. L. Michelsen, Dept. of Chemical Engineering, Virginia Polytechnic Institute, Blacksburg, Va. 24061

The growth of the synthetic textile industry has brought about problems of pollution. Synthetic fibers require dispersed dye systems for satisfactory dyeing. The wastes from these systems are difficult to treat using conventional techniques such as oxidation and biological reduction.

This investigation concerned the use of foam fractionation as a possible treatment method for dispersed dye wastes. Several dispersed dyes were used with sodium lignosulfonate as a dispersing agent. These materials were tested at concentrations similar to those leaving a commercial dye bath. Chemical oxygen demand (COD), color, and turbidity were used to monitor the results achieved. The effect of pH and liquid height above the sparger was investigated. Surfactants and polyelectrolytes were also added to the system to determine their effect.

The results indicate some degree of COD and color removal for all tests using foam fractionation. COD concentration 25-100% higher in the overhead products were observed with a 2-10% reduction in the bottom product. An increase of color concentrations of 50-200% were observed in the overhead products with a 20-50% reduction in the bottom products. Changes in pH, liquid height, and the additives had little effect on the results. Foam fractionation has proved to be a feasible technique for COD and color removal but to date is only marginal for industrial application.

ERRATIC MOTIONS OF BALLS AND BALLOONS. Robert M. Henry, NASA Langley Res. Ctr., Hampton, Va. 23685

The aerodynamic forces on a sphere moving through the atmosphere are disturbed by flow instabilities and shed vortices in the sphere's wake. These disturbances can be important in wind measurements using spherical balloons and drag sphere anemometers, as well as in sports and recreations such as golf and baseball. Examples of the disturbed motions of spherical balloons are shown and analogies are drawn with golfball and baseball motions. The historical development of golfballs and methods used to improve their flight are reviewed, and the application of the methods to increase the accuracy of wind measurements is illustrated.

ENGINEERING THE PROPERTIES OF BICONSTITUENT FIBERS FOR HOME FURNISHINGS USE. B. T. Hayes, Allied Chemical Corporation, Petersburg, Virginia, 23803

Product design and some process considerations involved in preparing a new biconstituent fiber are discussed. The structure of this fiber and its physical properties point to certain aesthetic and performance features that might be used to advantage in the home furnishing industry. The realization of these advantages is seen in the final product.

THE EFFECT OF A QUATERNARY AMINE ON NITRIFICATION IN THE BOD TEST. Bruce Shelton Hulcher* and Paul H. King, Dept. of Civil Engineering, Va. Polytechnic Inst., Blacksburg, Va. 24061

The effect of the quaternary amine, alkyl-dimethyl benzyl ammonium chloride (commercially called Zephiran Chloride) on nitrification in the biochemical oxygen demand (BOD) test was investigated. Frequently in a BOD test it is desired to find oxygen demand associated only with the carbonaceous material of a waste. The object of this work was to find a convenient and economical way to inhibit the nitrifying organisms while leaving the carbonaceous metabolism unaffected by the inhibitor.

The major method employed to determine if nitrification had occurred consisted of plotting the BOD curves for a sample containing glucose as a carbon source, but no ammonia source, a sample containing glucose and ammonia, and a sample containing glucose, ammonia and various concentrations of the inhibitor under study. The relative magnitudes of these curves were indicative of the extent to which the sample nitrified. To give further evidence of nitrification, analyses for nitrite by the alpha-naphthylamine method and for nitrate by the nitrate specific ion electrode were performed.

The experimental results indicated that although Zephiran Chloride does inhibit nitrification at very low dilutions, it presents another problem in that after a suitable acclimation period the carbonaceous population begins to use the inhibitor as an additional substrate.

DESIGN AND OPTIMIZATION OF A THERMAL CRACKING FURNACE FOR ETHYLENE PRODUCTION. B. A. McFadden and D. L. Michelsen. Virginia Polytechnic Institute 24061

The design of a furnace for thermal cracking ethane to ethylene has been simplified by a mathematical model of the process. Once reactor geometry and process conditions have been selected, the model will simulate the simultaneous kinetic reactions by calculating heat transfer, composition, velocity, temperature and pressure gradients through the tube. The design can be carried out for either a specified tube length or level of conversion.

To make the model practicable, a computer program has been written to do the calculations. In this form the model is readily available as a design or instructional tool. Then, manipulation of process conditions and reactor geometry can provide a simple optimization for a particular design.

AUTOCLOAVE CURING CYCLES FOR CONCRETE MASONRY UNITS. T. B. Redmond, Jr.,* Manager, Research and Development, National Concrete Masonry Association, Arlington, Va. 22201

Research described in this report is from an NCMA project designed to study various phases of the autoclave curing cycle in order to determine the most efficient combination to produce high-strength low-shrinkage concrete masonry units.

The drying shrinkage of units cured for 2 hours at maximum temperature was comparable to that obtained for units cured for 5 hours at maximum temperature. In most cases, compressive strength of units cured for 2 or 2½ hours maximum temperature were equal or slightly less than that of units cured for 5 hours maximum temperature. Effect of rate of temperature rise on strength was dependent on aggregate type and size of specimens, but a minimum of 3 hours generally produced best results in the laboratory. Data indicates that for a curing temperature of 400 F (235 psig) time at maximum pressure should be shortened to 1 hour.

LOW TENSION CONVEYORS. G.C. Roinestad, Res. and Development Dept., Ashworth Bros., Inc., Winchester, Va. 22601

The tension of a conveyor belt spiraling up or down around a powered central drum and supported by stationary rails can be expressed by the equation

$$T(\text{assymptotic}) = \frac{\pi w}{f} \left(\frac{f + \rho}{1 - \frac{f}{\rho}} \right)$$

where $\rho = \frac{\rho}{\pi} (\rho = \% \text{ slope})$ ($\Delta L = \% \text{ overdrive}$)

w = system radius

w = linear weight of belt + load

f = friction factor belt to support rail

F = friction factor belt to drum face

The quality of operation i.e. control of vibration or wave propagation can be influenced by adjusting value of ρ through changing ΔL (overdrive). The following qualitative rule applies...

...the greater the overdrive, the lesser the tension, but with increased vibration and wave propagation; conversely, the lesser the overdrive, the greater the tension, but with increased smoothness of operation. The tension values encountered in the "Low Tension System" are comparatively very low, and exceptionally long systems can be built and operated safely.

DIFFUSION THROUGH MONOLAYERS. R. R. Thomas, and J. L. Gainer. Dept. of Chemical Engineering, Univ. of Va., Charlottesville, Va. 22901

The rapid growth of our population, especially in the dry Western United States, has spurred research into effective water conservation methods in the last twenty years. The discovery that some oils, which are capable of being spread over a water surface in a film exactly one molecule thick and which also effectively retard the evaporation rate of water has focused a great amount of interest in the study of monomolecular films, or "monolayers". Particularly, attention has centered on the unique diffusion mechanism which takes place as the water evaporates through the film. Early investigators showed that the diffusion of water through a monolayer did not obey Fick's laws. A theory which views the monolayer as an energy barrier proportional to the size of a water molecule and the interfacial surface tension predicts the diffusion coefficients of a number of promising monolayers. It is hoped that this will greatly facilitate the determination of evaporation rates from monolayer-covered ponds and lakes.

THE AMF BLINDSTITCH FELLING MACHINE - A UNIQUE MACHINE THAT DUPLICATES HAND SEWING. P. J. West, President, Union Machinery Div., American Machine & Foundry Co., Richmond, Va. 23227

The men's tailored clothing industry is rapidly losing its skilled hand sewers. As the amount of hand stitching in certain construction phases of a suit coat determines the garment's "grade" or quality level, the industry's problem is critical. Hand stitching is especially important in the construction of the collar where several layers of fabric must be joined together to provide proper fit around the neck and shoulder areas of the wearer.

AMF has designed a unique new machine which exactly duplicates the hand "felling" stitch used to attach the collar. A curved needle is passed completely through the materials being sewn. The stitching mechanism is precisely timed with a garment feed to produce up to three stitches per second.

Since its introduction in September 1968, the AMF Blindstitch Felling Machine has been enthusiastically received by the apparel industry.

Section of Geology

Forty-Seventh Annual Meeting of The Virginia Academy of Science
May 8-10, 1969, Fredericksburg, Virginia

A Look at Estuarine Mollusk Species Diversity. Samuel O. Bird. Dept. of Geology, Mary Washington Col., Fredericksburg, Va. 22401

A modern measure of species diversity is obtained by summing products of the relative abundances of species times the natural log of relative abundances. The equation is: Species Diversity (SD) = $\sum p_i \ln p_i$. SD for any number of species (n) is maximized when all the p 's are equal. Because of this, the measure serves as an index to community structure. (Community structure is, of course, judged on relative abundance of species as well as species composition.)

Values of SD calculated from 69 stations from off-shore to the head of the Newport River Estuary in North Carolina present some interesting problems. The pattern of values is non-regular over the interval. Further, the ratio of observed to theoretical maximum SD shows a particular trend but this ratio is negatively correlated with theoretic SD . This condition is contrary to what is expected by probability considerations. Finally, and this is the most interesting fact, the ratio of observed to theoretical SD is positively correlated with percentage of deposit feeders. The correlation suggests that numbers of species within a community depends on community structures as indicated by per cent deposit feeders.

PETROGENESIS OF AN AMYGDALOIDAL DIAPASE DIKE, RAWLINGS QUARRY, VIRGINIA. Stephen C. Clement, Dept. of Geology, Col. of William and Mary, Williamsburg, Va. 23185

A diabase dike exposed in the Rawlings Quarry near Dinwiddie, Virginia, provides an excellent local example of classical crystallization theory. Crystallization inward from the walls of the magma chamber is illustrated by the presence of marginal chill zones showing crystal parallelism due to flowage and by a smooth variation in gross mineralogy and mineral composition from the walls to the center of the fourteen foot thick dike. The abundance and size of amygdules reach a maximum near the center of the intrusive.

Plagioclase laths range in length from approximately 0.5 mm. in the chill zones to 4.5 mm. in the center of the dike. Their composition vary from labradorite in the chill zones to andesine in the center. Olivine, variety chrysolite, is common near the margins of the intrusive but is absent in the center where titaniferous augite has crystallized in its place.

The central portion of the dike contains abundant amygdules in which analcime is the most common mineral. Associated with analcime are small amounts of pectolite, calcite, montmorillonite and a rare calcium silicate hydrate, reyerite. This occurrence of reyerite is thought to be the first reported in Virginia.

THE TYPICAL (?) PETERSBURG GRANITE. B.K. Goodwin, Dept. of Geology, Col. of William and Mary, Williamsburg, Va. 23185

The Petersburg granite of the eastern Piedmont of Virginia consists of three granite bodies extending from Ashland to the Virginia-North Carolina border. The largest exposed segment of this pluton underlying the cities of Richmond and Petersburg, is overlapped eastward by coastal plain sediments, and to the west is in contact with gneisses, metavolcanics, and Triassic sediments. Existing literature on the Petersburg granite presents an erroneous picture by suggesting that it is a rather homogeneous, uniform pluton, composed at most of three distinct phases.

Preliminary field work on the granite indicates that although locally uniform in composition, it is commonly heterogeneous. Some individual exposures contain great lithologic variation, both in texture and in composition. Textures range from pegmatitic to aplitic and from porphyritic to uniform. Composition may vary from gabbro to granite. Granite gneiss is dominant at several localities and inclusions of the host rock are often numerous. These inclusions frequently have their foliation oriented at variance with the foliation of the enclosing granite gneiss. In other inclusions foliation is parallel to that of the granite gneiss. Textural and compositional variability as well as pneumatic banding and xenoliths are not confined to the borders of the pluton but occur in the central portion of its exposed area as well.

BIOSTRATIGRAPHY OF THE YORKTOWN FORMATION (MIOCENE) ON THE SOUTH BANK OF THE JAMES RIVER, SURRY AND ISLE OF WIGHT COUNTIES, VIRGINIA. William G. Huber and Gerald H. Johnson, Dept. of Geology, Col. of William and Mary, Williamsburg, Va. 23185

The Yorktown Formation is exposed in bluffs along the south bank of the James River in Surry and Isle of Wight Counties. In this area the Yorktown Formation, composed of interbedded fossiliferous sandstone and sandy shell beds, conformably overlies the St. Marys Formation as defined by Mansfield (1943) and is overlain disconformably by post-Miocene sand, clay, and gravel.

Mansfield subdivided the Yorktown into two zones, a lower *Pecten clintonianus* zone and an upper *Turritella alticostata* zone. In the present study, Mansfield's zones were further subdivided into nine subzones in northern Surry County. Although the subzones are laterally extensive, the subzones thin and/or intertongue with other subzones up or downstream. The base of the *P. clintonianus* zone increased in elevation upstream in a steps-wise manner. The Chama subzone, Mansfield's lowest *T. alticostata* subzone, intertongues with the *P. clintonianus* zone downstream.

The regional distribution of sediments and fossils from the James indicate that the Yorktown was deposited in an oscillatory, shallow transgressive sea. Mansfield's zones are time transgressive and should not be used as time-stratigraphic units.

MECHANICAL ANALYSIS OF ESTUARINE BEACH SEDIMENTS. Bruce Rippy*, Dept. Geology, Col. of William and Mary, Williamsburg, Va. 23185

Sands of six estuarine beaches, three riverine and three of Chesapeake Bay, were sampled to compare size frequency distribution parameters with results reported by Friedman (Jour. Sed. Pet., 1967). Friedman reported his parameters effected excellent separation between beach sands and river sands.

Graphs of first percentile vs. 56.4 percent and Simple Skewness vs. 62.4 percent differentiate beach sands in this study and Friedman's. Graphs of Simple Skewness vs. Simple Sorting, and Simple Skewness (mode) vs. Simple Sorting, did not yield significant results in this study.

Friedman collected beach samples from the swash zone only, but channel samples across all beach zones were also collected in this study. Channel sample parameters generally lay within beach fields.

The critical factor in recognition of beach sands appears to be a lack of sediment finer than 62 microns. This results in a strong tendency toward negative skewness, although most samples in this study were slightly positively skewed. Positive skewness may be a general characteristic of estuarine beaches because of the relative abundance of fine-grained sediment available. Fines are not sufficiently abundant in estuarine beaches, however, to produce a significant overlap with the parameters of river sands.

X-RAY STUDY OF HEAT-TREATED PYROCHLORE-MICROLITE FROM VIRGINIA. Rudolph J. Zulkiewicz* and Richard S. Mitchell. Dept. of Geology, University of Va., Charlottesville, Va. 22903

The pyrochlore-microlite series is well known from the Amelia area. Contrary to common belief, recent semiquantitative spectrochemical analyses indicate most specimens are not typical microlite (the Ta end member), but varieties in which Ta and Nb are about equal. This is especially true of crystals from the Rutherford and Champion pegmatites; a Morefield sample showed Ta>Nb and abnormally high U, Th, Pb, and Ce. No good correlation between chemical composition and unit cell size (ranging from 10.40 Å, to 10.51 Å) or degree of metamictization was found. X-ray diffraction studies of heat-treated metamict specimens show recrystallization occurs between 400° and 500° C. Samples remain essentially pure pyrochlore-microlite up to 700°. A CaTa_3O_11 phase appears at 800° but disappears before 1000°. Ta_2F appears between 900° and 1000°. Very metamict samples finally break down to CaTa_3O_6 at 1000° and this phase persists and increases at higher temperatures. In Morefield specimens another major phase, Ta_2 , appears between 900° and 1000°.

LEACHING AND CEMENTATION OF COQUINA OF THE YORKTOWN FORMATION (MIOCENE), YORK-JAMES PENINSULA, VIRGINIA. Burt Waite* and Chris Condit*, Dept. of Geology, Col. of William and Mary, Williamsburg, Va. 23185

A field and laboratory study of selected molluscan genera from outcrops of the coquina facies of the Yorktown Formation on the York-James Peninsula showed differential removal of the mollusks in the leaching zone. The most extensively leached forms were composed of aragonite and the less altered forms calcite. Shells of *Crepidula* and *Chama*, both aragonitic, form molds in the upper part of the section and indicate severe leaching of these forms. *Mercenaria*, a massive aragonitic form, persists further upward in the weathering zone than the thinner-shelled *Chama* and *Crepidula*. *Plicatula*, composed of calcite with an inner argonitic layer, showed a progressive increase in the degree of corrosion of the inner layer higher in the leaching zone. The calcitic shells of *Pecten* were not leached except in the overlying saprolite.

This section study of the coquina reveals that the aragonite has been recrystallized to calcite in place in the partially leached zone, or has been leached out. Aragonite and calcite have been leached from the upper part of the section and have been precipitated as sparry calcite cement in the interstices of the coquina.

Section of Materials Sciences

Forty-Seventh Annual Meeting of The Virginia Academy of Science
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INTERACTION OF GASES WITH A DISCONTINUOUSLY FILLED ELASTOMER. II. COMPONENTS. F. I. Akers* and J. P. Wightman. Dept. of Chemistry, Va. Polytechnic Inst., Blacksburg, Va. 24061.

The results of absorption studies of CO_2 , He and H_2O by the individual components of a filled elastomer are reported. The colloidal-sized components were as follows: silica spheres, phenolic spheres and silica fibres. The matrix was a silicone elastomer. Absorption was measured at 27°C as a function of pressure by a manometric technique in a constant volume system. It was shown that He was absorbed predominantly by the silica spheres and significantly less by the phenolic spheres. CO_2 was absorbed predominantly by the phenolic spheres and somewhat less by the silicone elastomer. The absorption of CO_2 by the silica spheres was negligible. H_2O was absorbed by the phenolic spheres, the silica fibres and the silica spheres. The amounts of gases absorbed by the components correlates well with absorption by the filled elastomer. The results are discussed in terms of possible absorption mechanisms. (Aided by NASA-Langley Research Center Contract No. NAS1-7645).

OXIDATION OF EVAPORATED THIN FILMS OF TANTALUM. F. M. Berteig and K. R. Lawless. Dept. of Materials Science, Univ. of Virginia, Charlottesville, Va. 22901.

In the study of the oxidation of tantalum, the main approach to date has been to use bulk polycrystalline tantalum, observing it before and after the oxidation. By contrast, the present work involves thin film single crystal tantalum, observed in the electron microscope during the oxidation.

High purity tantalum has been deposited by electron beam evaporation onto hot polished {100} surfaces of single crystal MgO . After stripping from the substrate, these films have been mounted in the electron microscope for oxidation. The electron microscope has been modified to provide a vacuum in the vicinity of the sample that is better than that in an ordinary microscope column, and a controlled oxygen inlet has been inserted.

The diffraction patterns and microscopic structures obtained so far are similar to those attributed by some workers to Ta_{67}O_9 (Ta_2O_5) and TaO_2 (Ta_2O_5). However, they also resemble results attributed by other investigators to Ta_6C . Inasmuch as carbon has not yet been eliminated from the system, the latter is a more probable explanation.

This work was supported by the Office of Naval Research.

THE DUCTILE-BRITTLE TRANSITION IN POLYCRYSTALLINE MOLEYDENUM. Robert W. Bauer. Department of Materials Science, Univ. of Virginia, Charlottesville, Va. 22901.

The details of ductile-brittle transition in molybdenum of 17μ grain size and containing about 15 ppm interstitial impurities has been studied using electro-polished unnotched tensile specimens tested at a strain rate of 10^{-4} sec^{-1} . Electron fractography, using a replica technique, and optical metallography of fracture surfaces was carried out on representative specimens.

The results obtained show that the transition to complete brittleness occurred at -60°C . It was found that below the transition the brittle fracture stress lay along an extrapolation of the yield stress-temperature curve. Specimens which exhibited appreciable pre-yield microstrain tended to have a small yield drop and vice versa.

The electron and optical microscopy showed that the fractures were primarily transgranular with some intergranular facets, at temperatures below 0°C . The cleavage facets were often found to be terraced. These results will be discussed in terms of a model for fracture first proposed by Johnson and Shaw (1959).

SOLID STATE SWITCHING IN SEMICONDUCTING GLASSES. P. R. Eusner* and L. H. Slack. Dept. of Metals and Ceramic Engineering, VPI, Blacksburg, Va. 24061.

Several of the chalcogenide semiconducting glasses exhibit a switching phenomenon. A sufficiently high voltage between two contacts on the semiconducting glass will cause the glass to become a relatively good conductor. The insulating state is regained when a large current is passed between the two contacts.

The resistance of the insulating state was found to depend on the rate at which the current was decreased when the switch was in the conducting state. This is evidence that the switching phenomenon is associated with a structural change. Another type of switching was observed which did not demonstrate a memory effect. The switching was so rapid that apparently no structural change is involved. Possible switching mechanisms are discussed.

TRIBOLOGY: DEFORMATION AND AREA OF CONTACT BETWEEN SOLIDS.
M. J. Furey, Dept. of Mechanical Engineering, Virginia
Polytechnic Institute, Blacksburg, Virginia 24061

One of the key unknowns in the study of the solid-solid interface in general and tribology (having to do with the rubbing process) in particular is the real area of contact.

Using a new device developed for studies on the physics and chemistry of solids, an experimental investigation of microtopography and area of contact has been made. The apparatus consists of a fixed specimen (e.g., a sphere) loaded against a transparent plate such as an optical flat. Plateaus of apparent contact for both reflective and transparent specimens can be observed and photographed by means of vertical illumination with white or monochromatic light.

Several polymers and pure metals—including Ag, Cd, In, Sn, Au, Pb, and Bi—were studied. In static tests, it was found that the optically-determined contact area was equal to kW^2 where W is the normal load and k varied from about $2/3$ to 1 , depending on the solid and load range. The behavior of the polymers was generally elastic. Furthermore, the experimental data showed excellent agreement with the Hertz theory for the deformation of a single elastic sphere on a non-deformable plane. With the metals, the contact area was generally governed by plastic deformation, although the experimental values were consistently higher than the theoretical. It was also found that details in the surface structure tended to persist throughout the application of higher normal loads.

LOSS OF COHERENCY BY SPHERICAL PRECIPITATES.
W. A. Jesse, Department of Materials Science,
University of Virginia, Charlottesville,
Virginia 22901

The equilibrium misfit of a spherical precipitate is shown to depend on precipitate size. An expression is derived for the critical precipitate radius beyond which loss of coherency is energetically favorable. Comparison of experimental observations with the theory yields fair agreement.

FRICITION AND WEAR CHARACTERISTICS OF HOT PRESSED MoS₂-Ni COMPOSITES IN A FACE SEAL CONFIGURATION. J. J. Kauzlarich,
W. E. Neuhauser,* Dept. of Mechanical Engineering, Univ. of
Virginia, Charlottesville, Va. 22901.

Experimental friction and wear tests for hot pressed MoS₂-Ni composites were run in air and results showed that increasing the percent MoS₂ in a composite decreased the coefficient of friction with a limiting value equal to that of a 100% MoS₂ film. However, the wear rate was greater than that for pure nickel. A composite of 5% MoS₂ exhibited a much lower (mild) wear performance at loads of less than one pound than composites tested containing a greater percent MoS₂. From X-ray analysis of the composites it was found that a large percentage of the original MoS₂ was degraded by the hot pressing operation. The tests were performed with composites in a face seal configuration, and wear theory for this study was developed based on the Archard Wear Law.

INVESTIGATION OF METALLIC FOILS WITH THE 500-kV ELECTRON MICROSCOPE. Roy H. Geiss, Department of Materials Science, University of Va., Charlottesville, Va. 22901

One of the major advantages in using higher voltages in the electron microscope is the ability to penetrate thicker foils while maintaining the same resolution as with 100-kV. This follows from the decrease in chromatic aberration due to energy losses in the sample.

In addition, as the voltage increases the diffraction pattern gets smaller, being proportional to the electron wavelength, with the result that high resolution dark field images are attainable by simply displacing the objective aperture.

These effects will be demonstrated using examples of oxidized tantalum, stacking faults in vanadium Ag-Sn and Cu-Al, and dislocation structures in various materials. Magnetic domain structures in nickel foils will also be shown.

Support for this work was obtained through the Office of Naval Research.

OXIDE PLATELET FORMATION IN BULK TANTALUM. D. J. Kompe*
and K. R. Lawless. Dept. of Materials Science, Univ. of Virginia, Charlottesville, Va. 22901

High purity 5 mil tantalum specimens have been oxidized over the temperature range 500 to 700°C in the pressure ranges 5×10^{-4} to 5×10^{-2} torr oxygen. The oxidation was followed directly by joining an optical microscope and a vacuum heating stage. It was seen to proceed by the formation and growth of microscopic platelets which appeared as arrays of fine needles in the specimen surface.

Samples were electropolished in a 90% H₂SO₄ · 10% HF (by volume) solution at 10 volts for observation in either a Siemens 100kV or RCA 500kV Electron Microscope. It was noted the oxidized specimens were extremely brittle which adversely affected their thinning characteristics.

Transmission electron microscopy (TEM) and selected area diffraction (SAD) showed the so-called tetragonal Ta₂O₅ suboxide ($a = 6.68\text{\AA}$, $c = 4.75\text{\AA}$) had formed and extended through the 5 mil samples. TEM clearly indicate the platelets grow along certain well defined and unique crystallographic planes which SAD show to be {100} Ta.

This work was supported by the Office of Naval Research.

PHASE EQUILIBRIA AND LUMINESCENCE IN A PORTION OF THE BaO-Ba₂V₂O₅ SYSTEM. P. V. Kelsey* and Jesse J. Brown, Jr.*
Dept. of Metals and Ceramic Eng., VTI, Blacksburg, Va. 24061.

The phase equilibria relationships in a portion of the BaO-CdO-V₂O₅ system have been established in air from data obtained by differential thermal analysis, quench and round trip high-temperature solid state reaction experiments.

Compound formation in the BaO-V₂O₅ boundary system closely parallels that in the analogous BaO-P₂O₅ system. Three compounds were isolated in the BaO-V₂O₅ system at molar ratios of 3:1, 2:1 and 1:1. Barium orthovanadate was found to undergo a sluggish polymorphic transition at 580°C. The compounds present in the CdO-V₂O₅ system are also similar to those in the cadmium phosphate system. The three compounds isolated were found to occur at the approximate molar ratios of 3:1, 2:1 and 1:1. The latter compound, cadmium metavanadate, has a rapid reversible transition at 180°C.

Ba₂V₂O₇ is a yellow-green emitting self-activated phosphor when exposed to ultraviolet excitation. All of the other compounds examined were found to be inert.

INFLUENCE OF ULTRASONICS ON THE PROPERTIES OF PULP FIBERS.

P. Labosky, Jr., V.P.I., Blacksburg, Va. 24061.

Ultrasonic vibrations as a potential source of energy has been investigated in the past twenty years. Recently, investigations suggested that desirable fiber characteristics for papermaking can be obtained from ultrasonic beating. The objectives of this experiment were to evaluate ultrasonic beating and determine what changes occur in the paper properties.

Wood pulps were beaten ultrasonically with a Blackstone ultrasonic generator to different Canadian Standard Freeness levels (CSF) and made into handsheets. The handsheets were made according to TAPPI procedures and evaluated for physical and mechanical properties. Procedures were developed for ultrasonic beating.

Results showed that high bulk values were obtained at the high CSF levels but there was a slight reduction of bulk properties at the low CSF levels. Initial tear values were low at the high CSF levels but increased steadily to an optimum value before decreasing slightly at the low CSF levels. Tensile properties were poor throughout the CSF range with some improvement at the low CSF levels.

Inferior tensile properties were attributed to the resistance of the treated pulps to fiber collapse during the drying process. Observations under the electron microscope indicate that the S_2 layer of the ultrasonically treated pulp is not sufficiently weakened to promote fiber collapse, resulting in high bulk and low tensile strength properties.

COMPUTER SIMULATED ELECTRON DIFFRACTION PATTERNS OF TWO

PHASE CUBIC CRYSTALS. Gregory H. Olsen and William A. Jesser. Department of Materials Science, Univ. of Va., Charlottesville, Va. 22901

A computer technique for predicting electron diffraction patterns of two-phase cubic crystals having specific orientation relationships will be discussed. The program uses the given orientations to rotate the beam from the coordinate system of one phase to the other, via matrix methods, whereby the Bragg condition for a particular plane may be checked. Diffraction patterns corresponding to the Bain, Nishiyama, Kurdjumov-Sachs, and Pitsch orientations of body-centered cubic precipitates in face-centered cubic structures have been predicted in such a manner and will be displayed. The pattern associated with multiple twinning in face-centered cubic metals has also been computed and will be displayed.

HIGH VOLTAGE ELECTRON MICROSCOPY AT THE UNIVERSITY OF VIRGINIA.

K. R. Lawless, R. H. Geiss, and H. G. F. Wilsdorf. Department of Materials Science, University of Virginia, Charlottesville, Va. 22901

Installation of a 500-kV electron microscope has recently been completed in the Department of Materials Science at the University of Virginia. The advantages of using high voltages for transmission electron microscopy will be discussed with respect to resolution, transmissivity, and radiation damage. A description will be given of the Virginia installation. Micrographs illustrating some of the applications to metallic samples will be shown and discussed.

RELATIONSHIP BETWEEN FLOW STRESS RECOVERY AND DISLOCATION STRUCTURE IN POLYCRYSTALLINE ALPHA-TITANIUM.

P. Chandra and K. R. Lawless, Dept. of Metals and Ceramic Eng., Virginia Polytechnic Institute, Blacksburg, Va. 24061

Cell structure was observed by transmission electron microscopy in polycrystalline alpha-titanium deformed 10% true strain at room temperature. These cells appeared to be slightly elongated rather than equiaxed. The most predominant cell boundaries were found to lie on the $\{10\bar{1}0\}$ type planes. Flow stress recovery of alpha titanium at 500 and 550°C proceeded in two stages; an initial rapid recovery during the first 6 hours, and a leveling off after 6 hours. During the first stage of recovery, significant rearrangement of dislocations took place, and rather regular dislocation loops appeared to surround the subgrains. The segments of these dislocation loops were found to lie along $\langle10\bar{1}0\rangle$ type directions on the $\{0001\}$ plane, and $[0001]$ type directions on the $\{11\bar{2}0\}$ planes. In the second stage, continued rearrangement of dislocations resulted in well-defined sub-boundaries. The segments of dislocations lying along the $\langle10\bar{1}0\rangle$ type direction tended to react to form networks on the basal plane, and those lying on the $\{11\bar{2}0\}$ planes continued to remain aligned along $[0001]$ direction. It was postulated that many of the subgrains formed as a result of a twist about the $[0001]$ axis, forming pure twist networks on the $\{0001\}$ planes and pure tilt boundaries on the $\{11\bar{2}0\}$ type planes.

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EFFECT OF BARIUM OXIDE ON THE DESULFURIZING CAPACITY OF SLAGS.

G. S. Powley* and T. P. Floridis, Virginia Polytechnic Institute, Blacksburg, Virginia. 24061

The desulfurizing capacities of slags were evaluated by measuring the distribution of sulfur between a slag phase and a metal phase at equilibrium.

Synthetic slags and carbon-saturated iron contained in graphite crucibles were equilibrated at 1520°C under a carbon monoxide atmosphere at a total pressure of 1 atmosphere.

For similar basicities, slags containing barium oxide have higher desulfurizing capacities than slags containing calcium oxide.

(Support by the American Iron and Steel Institute is gratefully acknowledged).

A THREE DIMENSIONAL GEOMETRIC MODEL FOR NORMAL GRAIN GROWTH.

J. H. Steele, Jr., Dept. of Metals and Ceramic Eng., VPI, Blacksburg, Va. 24061.

A three dimensional geometric model for normal grain growth in polycrystals has been developed. The model consists of the annihilation sequence for individual grains that results from the collapse of triangular faces in the boundary network. The geometric and topological changes, which occur as a result of this structural event, indicate that two separate stages of normal grain growth can occur. First, a change in the average grain shape toward the equilibrium value of 13.56 faces per grain either with or without annihilation. Second, a steady state condition where small variations in the average grain shape occur during the systematic grain annihilation.

The model provides an explanation of the linear statistical relationship between the size and shape distributions, and the invariance of their functional form during normal growth. It also emphasizes the distinction between the phenomena of normal and abnormal growth wherein grains with a larger number of faces tend to consume their neighbors under the influence of their concave curvature. (Sponsored by J. L. Lytton)

FAILURE IN WOOD AT THE SUBMICROSCOPIC LEVEL. T. SZABO* and G. A. Grozdits, Dept. of Forestry and Wildlife, Virginia Polytechnic Institute, Blacksburg, Va., 24061.
The objective of this study was to associate the submicroscopic appearance of the mechanical failures (minute cracks) with cell wall structure in wood.

Wood can be visualized as a fiber reinforced plastic in which lignin is the incrusting material while the long chain cellulose molecules are the reinforcing elements. The cellulose chains aggregate into well-oriented microfibrils which in turn have a crystalline structure. The unit cell dimensions of that structure are known but its degree of crystallinity can only be approximated. The cellulose network therefore is neither unique nor homogeneous and points with different strength properties are distributed statistically in the microfibrils.

When wood is subjected to stress conditions the resulting minute deformations in the cellulose network will be initiated at those points which have the lowest strength properties. Once the minute cracks are formed the stress or strain fields near the tips are intensified, then due to these facts the cracks propagate along the weakest plains closest to them. The propagated minute cracks or so called "slip-lines" generated by different stress conditions were observed under an Electron Microscope. The observations are clearly shown that the weakest plains are coinciding with the microfibrillar orientation regardless of the stress conditions.

FRACTURE TOUGHNESS OF HIGH STRENGTH ALUMINUM ALLOYS R.E. Zinkham*, J. H. Jackson & J. H. Dedrick, Metallurgical Res. Div., Reynolds Metals Company, Richmond, Virginia, 23219

From golf club shafts to aerospace applications the heat treatable or precipitation hardening aluminum-zinc-magnesium-copper alloys give the best combination of high strength and fracture toughness where weight-savings are important. Various methods of evaluating the fracture toughness of these materials are considered including the linear elastic fracture mechanics approach. Application of these methods are used to relate the fracture characteristics with material thickness, chemistry, aging, fabrication practice and temperature.

Studies have shown that the fracture toughness may vary considerably due to anisotropy and thickness in 7075-T6 material. Generally with increasing thickness, the fracture mode changes from shear to flat fracture, a lower energy mode. However, it has been found that if fibrous fracture develops, the fracture may be predominately flat and still yield relatively high values of toughness. Work has shown that toughness may be increased by removing insolubles as well as by preforging. For a given yield strength, toughness is best in the underaged condition albeit that stress corrosion is not. Transition effects due to temperature are indicated.

Section of Medical Sciences

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A SCALE MODEL OF EGG-WHITE LYSOZYME, Edward R. Berry and William E. Keefe, Dept. of Biophysics, Med. Col. of Va., V.C.U., Richmond, Va., 23219

The commercially available atomic models are a compromise of the measurements reported from crystallographic data. With the availability of the coordinates of the protein, chicken egg-white lysozyme, from Dr. Phillips, it is now possible to construct a model of this enzyme. The individual amino acids were constructed according to their dimensions from x-ray crystallography i.e. eleven different carbon atoms in tryptophane, and each residue was then incorporated into the model. A total of 129 units were required. The technical difficulties encountered and the necessity of an alpha carbon atom model and X-Y plots to aid in the construction are discussed. The content of polar and non polar groups, alpha helix, beta pleated sheet, sulphydryl bridges and general conformation are considered. The importance of steric hindrance in sequential construction of the protein is emphasized. The correlation of activity and structure by the use of this model are evaluated.

RETINAL TEMPERATURE RISE DUE TO VIEWING VISIBLE AND NEAR VISIBLE LIGHT SOURCES. A. M. Clarke and W. T. Ham, Jr., Dept. of Biophysics, Med. Col. of Va., V.C.U., Richmond, Va., 23219

Optical sources sufficiently bright to be considered a hazard to the retina include the sun, nuclear fireballs, lasers, and high pressure Xenon lamps. Applying the steady state heat conduction equation to a simple model of the retina and using the absorption coefficients for the pigment epithelium and choroid which have been reported in the literature, temperature elevations of the retina may be calculated as a function of the size of the image and the spectrum of the source.

Power inputs to the eye sufficient to cause a 1° C temperature rise are given for several optical sources. (Supported by contract DA 49 146 XZ 416, Defense Atomic Support Agency, and contract DA 49 193 MD 2241, U. S. Army Medical Research and Development Command, Office of the Surgeon General).

RADIATION CATARACT FROM ACUTE PROTON EXPOSURE. S. F. Cleary, W. T. Ham, Jr., W. J. Geeraerts, R. C. Williams, H. A. Mueller*, and R. K. Hale*. Depts. Biophysics and Ophthalmology, Virginia Commonwealth Univ., Med. College of Virginia, Richmond, Virginia, 23219.

Among the biological stresses presented by the environment in space, solar flare proton irradiation poses an unavoidable radiobiological problem. A study has been completed of one aspect of this problem; namely, the cataractogenic effect of acute exposure to proton radiation. Temporal variations in the average degree of lens opacification were followed in a group of 36 rabbits exposed to either 100 Mev or 30 Mev protons at doses of 25, 50, 100, and 250 rads. The results are compared with the results of a similar study in which the radiation source was 1 Mev x-rays. Information was thus obtained on the relative biological effectiveness of protons versus x-rays. (Research supported by NASA Grant NGR 47 002 005).

EFFECTS OF DIFFERENT LEVELS OF SOCIAL STRESS, ENDOGENOUS-EXOGENOUS STEROIDS, ACTH, AND INHIBITORY SUBSTANCES IN CHICKENS, AS RELATED TO RESISTANCE AND SUSCEPTIBILITY TO SOME BACTERIAL AND VIRAL INFECTIONS. G. Colmano and W. B. Gross, Dept. Vet. Sci., V.P.I., Blacksburg, Va. 24061

Stress in chickens was measured fluorimetrically as endogenous corticosterone levels in blood plasma taken before and when toxin challenged, one hour after administration of exogenous chemicals. In low and medium-low stress, administration of corticosterone, doubling the endogenous level, decreased endogenous corticosterone, while administration of ACTH increased it. *E. coli* at 1 hr gave 25% pericarditis for ACTH and 50% for corticosterone. In medium stress endogenous corticosterone increased after administration of dehydroepiandrosterone, prednisolone, pregnenolone, cortisol, cortisone and decreased after administration of dexamethasone, prednisone, corticosterone. A sex difference response was found using *E. coli* with dexamethasone, low stress, dehydroepiandrosterone and prednisolone, giving more severe lesions in males than females, while ACTH, prednisone and pregnenolone gave prevalent lesions in females. Cortisol, cortisone and corticosterone gave no sex preference. In high stress, *E. coli* pericarditis decreased from 85 to 50 and 20% by increasing stress levels from low to medium and high. Death by staphylococcus cultures were similarly 90% in low stress and only 10% in high stress. An opposite relationship held true for Newcastle disease, with death of 30% in low stress and 80% in high stress and for *Mycoplasma gallisepticum* infection where lesions increased with increasing stress.

THE FINE STRUCTURE OF THE EMBRYONIC MAMMALIAN OPTIC NERVE. T. M. Harris, Dept. of Anatomy, Med. Col. of Va., Richmond, Va. 23219.

A survey of embryos from timed matings indicates that the developmental period for the hamster optic nerve extends from day 8 when the optic vesicles appear through day 16, the day of birth; to the second post-natal week when the eyes open. In this span of time we have recognized six well-defined phases in optic nerve development: 1) Undifferentiated stalk stage, day 8 of gestation to day 11; 2) Stage of nuclear migration and nerve fiber invasion, day 11-12; 3) Nerve fiber proliferation stage, day 14(3/4); 4) Glial differentiation stage, day 13-14; 5) Glial proliferation stage, day 14-first week post-natal; 6) Myelination stage-second week post-natal.

This present report is from a preliminary study and deals with an electron microscopic analysis of the first three of the foregoing six stages. Ultrastructural changes in the stalk cells are described as they begin to differentiate into the glial cells of the definitive optic nerve. Their role in the formation of the glial limitans and the glial sheets is discussed. Finally the process of nerve fiber invasion is described in detail with emphasis on the interrelation between the stalk cells and the invading fibers. (Supported by NIH Grant HD-1789.)

EFFECT OF WEANING AGE OF PIGLETS ON *E. COLI* TOXIN RESISTANCE AS RELATED TO STEROID LEVELS IN BLOOD PLASMA. G. Colmano and J. W. Davis*, Dept. Vet. Sci., V.P.I., Blacksburg, Va. 24061

Eleven litters of 4 to 12 piglets each were weaned and bled between 21 and 47 days after birth. At a second bleeding, increasingly spaced away from weaning, they were given intravenously *E. coli* toxin and were then bled again 5 hours later. Weaning is a stressful event, reorganizing the nutritional balance, and the toxin challenge acted as an added stressor. Corticosterone levels in blood plasma were used as a measure of stress. Averages for ug corticosterone levels % blood plasma in all 11 groups gave respectively 9.28 (34 pigs) and 8.22 (60 pigs) for the first and second bleedings, with a distinct increase to 16.57 at 5 hrs after toxin challenge. The overall slight decrease between 1st and 2nd bleeding indicates a decrease in stress with adaptation to it, while the increase after toxin challenge gives a measure of stress increase. Natural weaning usually occurs around eight weeks of age, while the earliest empirically least troublesome period appears between 30 to 35 days. Up to 26 days there is a high corticosterone level which tends to decrease from 26 to 35 days. After 35 days the corticosterone level decreases at a slower rate, associated with a lower level of susceptibility to infection. Also, the observation that high steroid levels are indicative of a good defense to bacterial infection, while showing an increase in susceptibility to viral diseases, would indicate the period between 30 and 35 days from birth as the optimum period for weaning and optimum resistance to infections.

EFFECTS OF HEMOLYTIC *ESCHERICHIA COLI* TOXIN ON THE CLINICAL BLOOD DETERMINATION OF PIGS WEANED AT DIFFERENT INTERVALS. J. W. Davis* and G. Colmano, Dept. of Vet. Sci., V. P. I., Blacksburg, Va. 24061

One to three pigs, out of 83, weaned at various intervals up to 48 days of age, were bled a first time, then at different intervals after bleeding were rebled and given intravenously *E. coli* toxin, and finally bled again at 5 hours. Blood samples were tested for hemoglobin, WBC, sedimentation rate, hematocrit, glucose, thymol turbidity, differential count and steroids. While there was no noticeable difference between the two normal blood samples, there was an observable increase in the hemoglobin, hematocrit and steroid values, with a decrease in WBC and glucose for blood samples taken at 5 hours. Four groups of pigs were weaned at 22, 24 and 25 days of age. A challenge with *E. coli* toxin resulted in 10 dead pigs and 7 alive up to 29 days, while challenge from 30 to 37 days gave only 2 deaths out of 12 pigs. Three groups of pigs weaned at 27, 28 and 29 days of age showed 11 dead and 5 alive after challenge up to 34 days of age and from 35 to 40 days challenge there was one death with eight alive. Four groups of pigs were weaned, two at 34 and two at 36 days of age respectively. Pigs challenged from 34 to 40 days showed 2 dead and 16 alive while of those from 41 to 48 days of age all 11 remained alive. Our determinations would indicate that pigs weaned after 30 days of age ought to be more resistant to disease than those weaned before this age.

THE SPARK CHAMBER AND THE PATHOLOGICAL THYROID. R. C. Hart and W. P. Trower, Physics Dept., Va. Polytechnic Inst., Blacksburg, Va. 24061

Early detection of thyroid abnormalities utilizes the fact that the gland, which has a higher affinity to iodine than surrounding tissue, normally distributes this element evenly throughout its volume. Conventional techniques involve scanning the area of the throat after the patient has received an injection of radioactive iodine 131I. In the scanning a β -ray from the decay of the iodine passes into a highly collimated scintillation counter. Although the spatial resolution of the measured silhouette may be improved by increasing the dosage of the radioactive material or the counting time, the first is harmful to the gland, while the second requires excessive expenditure of medical technician time. Our proposed system utilizes, as a detector, a spark chamber, conforming to the shape of the neck, which has a resolution time of 10 mil sec. This permits the reduction of the measurement time and the dosage, while increasing the spatial resolution of the image. Digitized readout to magnetic tape is used. Visual representation of the thyroid silhouette on a cathode ray scope which can be rotated in space and sectioned during the diagnosis at some future time is the use to which this data tape will be put.

A BASEMENT MEMBRANE COMPONENT IN THE LENS-OPTIC VESICLE INDUCTION SYSTEM. R. Hendrix* and J. Zwaan, Dept. of Anatomy, School of Med., Univ. of Va., Charlottesville, Va. 22901.

Investigations were carried out on the lens-optic vesicle induction system in the 48 hr. chicken embryo by autoradiography after labeling with ^3H glucosamine, ^3H proline, and ^3H glutamic acid for 0.5-6 hrs., and histochemistry utilizing the periodic acid-Schiff reaction. ^3H proline and ^3H glutamic acid were localized generally and nonspecifically. PAS reactivity and ^3H glucosamine labeling were strongly and specifically localized to the basement membranes between the interacting tissues--lens and optic vesicle. Comparison of the embryos labeled for 0.5-6 hrs. showed an increase in the grains over the lens and optic vesicle cells and the apposed basement membranes. We conclude that 1) a glycoprotein is present in the involved basement membranes, 2) this component is synthesized by the interacting lens and optic vesicle cells. The authors suggest a reinterpretation of basement membrane structure, which would interrelate the glycoprotein of this study to embryonic collagen. In terms of lens determination, an interfacial microenvironment may exist, which could play a crucial role in induction by adhesion and filtration abilities. (Supported by NSF grant GB-3236).

COMPARATIVE BIOCHEMISTRY OF MITOCHONDRIAL FUNCTION IN ASPERGILLUS NIGER. E. S. Higgins* and W. H. Friend*, Dept. of Biochemistry, Med. Coll. of Va., Richmond, Va. 23219.

Two strains of *A. niger* catabolized glucose predominantly via different mechanisms. The wild strain during growth utilized a cytoplasmic direct oxidative pathway and had very little citrate cycle activity. Conversely, a nitroaryl-resistant strain utilized the mitochondrial route but not the cytoplasmic direct path. Mitochondria prepared from the two strains satisfied standard criteria for structural and functional integrity and displayed a higher degree of respiratory control than those from fungi reported by others. Organelles from the resistant strain respired more vigorously and were more sensitive to phosphate acceptor control than were wild strain mitochondria. The major respiratory chains in both strains were similar to those in mitochondria from higher organisms although NADH was freely permeable to the intact organelles. The increased magnitude and efficiency of mitochondrial function in the resistant strain can explain dominance of the citrate cycle in that strain, in comparison to the cytoplasmic oxidative path in the wild strain. These are the first observations of markedly dissimilar mitochondrial function in two strains of the same organism grown under identical aerobic conditions. (Aided by NSF Grant GB 5886)

IMPROVED TECHNIQUE FOR RANGE MEASUREMENT OF ALPHA PARTICLES IN LIQUIDS. C. Eugene Moss. Dept. of Radiology, Med. Coll. of Va., Richmond, Va. 23219.

An improved method for the range measurement of low energy alpha particles in various liquids has been devised. The method centers around simple interferometer and scintillation techniques and adaptations. A wedge-shaped liquid film is established from a glass sourceholder and a plastic phosphor, which is mounted onto a photomultiplier tube in a light-tight box. Plots of counting rates versus thickness give inclined straight lines which can be made to intersect background counting rates at certain discriminator levels. The range value is found by extrapolating to zero discriminator level using these intersections. The thickness of the liquid film is determined by counting the number of interference fringes, using photomicrography principles established by monochromatic light incident upon the system.

Preliminary results on the use of such a system are reported and comparisons of the technique with other range methods are made. (Aided by A. D. Williams Research Grant)

MODIFICATION UPON EXISTING X-RAY MACHINE SIMULATOR Philip B. Norton* and C. Eugene Moss, Dept. of Radiology, Med. Coll. of Va., Richmond, Va. 23219.

A report is made of a series of modifications in an x-ray machine simulator originally designed by Trout in a previous article. Modification of this design have made the simulator more eye appealing, compact and useful, as well as more instructive. A discussion of these modifications and the reasons for each are presented, pictures of the modified design are shown, and cost figures are presented.

THE USE OF COUNTERCURRENT DIALYSIS IN AN ASSAY FOR TRANSFER RIBONUCLEIC ACID. Charles H. O'Neal Dept. of Biophysics, Med. Col. of Va., V.C.U., Richmond, Va. 23219

Recent studies on the role of multiple species of t-RNA in the regulation of protein synthesis necessitate rapid and sensitive methods for fractionation and assay of newly synthesized and modified amino acyl t-RNA species. One approach to increasing the sensitivity and reproducibility of the assay and facilitating automation is the use of the Craig countercurrent dialyzer to separate amino acyl t-RNA from unattached amino acids.

It is possible to utilize this device for the assay of any reaction in which a dialysable substrate is incorporated into a non-dialysable product such as protein or nucleic acid synthesis, H^3 exchange and binding studies. The apparatus and some examples of its use in these studies will be described. (Aided by Dr. H. C. Chen and Dr. Lyman Craig at the Rockefeller University)

NUCLEAR MIGRATION AND CYTOPLASMIC MICROTUBULES IN THE EMBRYONIC CHICKEN LENS INVESTIGATED WITH COLCEMID. T. L. Pearce* and J. Zwaan, Dept. of Anatomy, Univ. of Va., Charlottesville, Va. 22901

Colcemid was used to confirm earlier autoradiographic studies on interkinetic nuclear migration in the lens placode of the chicken embryo. Normally, almost all nuclei are located in the abluminal end of the tissue, but in embryos exposed to Colcemid from 1 to 4 hours *in vivo* mitotic figures accumulated progressively with time at the luminal surface of the lens. Since no mitoses were observed elsewhere in the tissue, this is taken as evidence for nuclear movement synchronized with certain phases of the cell cycle.

The effect of Colcemid on microtubules in the elongated cells of the developing chick lens was investigated with the electron microscope. Typical cytoplasmic microtubules present in large numbers in the paranuclear and apical parts of normal lens cells were disaggregated by Colcemid and were almost entirely absent from lenses 2 hours after treatment. Because the pseudostratified columnar nature of the lens was not destroyed at once by Colcemid in spite of the complete loss of microtubules, it is suggested that cytoplasmic microtubules alone do not maintain cell elongation in this system. (Supported by NIH Predoctoral Fellowship no. 1-F1-GM-39,219-01 and grant no. GB-3236 from the National Science Foundation)

RESULTS OF A PRELIMINARY STUDY FOR DETERMINING THE PLACEMENT OF PERSONNEL FILM BADGES ON RADIOLOGIC TECHNOLOGISTS DURING DIAGNOSTIC X-RAY PROCEDURES. Margaret M. Quinn*, School of Radiologic Technology, Med. Coll. of Va., Richmond, Va. 23219

There appears to be much contradiction in the literature as to where personnel film badges should be placed during x-ray procedures. In order to determine an answer for this question, as well as to understand certain additional aspects of radiation safety, the class of '70, School of Radiologic Technology, undertook a study to determine the position for the film badge during diagnostic x-ray procedures.

Eight students were monitored at four different positions on the body during their normal work day for a period of three months with commercially-obtained film badges. The data obtained from this preliminary study is presented and discussed. The lack of knowledge on the placement of such badges is pointed out and illustrated; conclusions are made and compared with previous recommendations.

EFFECT OF ADRENALECYTOMY ON BLOOD VOLUME AND VENTRICULAR FUNCTION. M.J. Rovetta*, R.L. Verrier, and A.M. Lefer. Dept. of Physiology, Univ. of Virginia, Sch. of Med., Charlottesville, Va.

Blood volume and ventricular function were studied in both acute and chronic adrenally insufficient cats in order to assess the importance of these factors in the post-adrenalectomy cardiovascular collapse. The reduction in blood volume determined by ^{131}I serum albumin (RISA) in acute adrenalectomized cats was not significantly different from sham operated controls in either open-chest or closed-chest cats. Although, chronically adrenalectomized animals exhibited classical signs of adrenal insufficiency (i.e., decrease in arterial blood pressure and in plasma Na^+ , and an increase in plasma K^+), the blood volume 10 days post-adrenalectomy was not altered. However, the maximal occluded dp/dt (mm Hg/sec.) and peak occluded left ventricular pressure at this time were impaired 59% and 40% respectively. Chronically adrenalectomized cats maintained on water rather than 0.9% NaCl exhibited a 21% reduction in blood volume. However, cardiac function in these animals was not further reduced compared to the saline maintained group. It is concluded that cardiac impairment occurs during adrenal insufficiency in the absence of a significant blood volume change. Furthermore, the impairment of the heart is of sufficient magnitude to account for the cardiovascular collapse following adrenalectomy and appears to be a major precipitating factor in this phenomenon.

ISOLATION OF GLYCOCEN IN DENSITY GRADIENTS OF SODIUM IOTHALAMATE. R. B. Scott, L. W. Cooper*, K. Hull*, and C. Hart*. Dept. of Medicine, Health Sciences Div., Virginia Commonwealth University, Richmond, Va. 23219

An ideal density gradient material for glycogen isolation would be one with high viscosity, and low reactivity with glycogen particles.

The density of 80% iothalamate is 1.499. The density varies linearly with refractive index. Iothalamate does not interfere with the anthrone determination of glycogen. Starting with iothalamate solutions of density 1.45, gradients of iothalamate varying from 1.3 to 1.6 density are formed during extended centrifugation at 40,000 rpm in an SW 50 rotor.

Rat liver homogenates are prepared in 0.01 M Tris, pH 8.0 and nuclei are removed at 800 g. A layer of 2.5 ml of iothalamate of density 1.45 is placed in a titanium 50 rotor tube and a thin layer of 70% sucrose layered above it. The post-nuclear supernate is then added and the tubes spun at 45,000 rpm for three hours. A band containing glycogen forms in the upper portion of the iothalamate while the membranes and granules remain at the sucrose-homogenate interface.

The iothalamate layer is then placed in the SW 50 rotor and the gradient formed during centrifugation. Isopycnic banding of glycogen occurs at a density of about 1.45 to 1.48.

ULTRASTRUCTURAL GLOMERULAR CHANGES IN HUMAN HOMOTRANSPLANTS LEADING TO NEPHRECTOMY. H. R. Seibel, R. J. Weymouth*, M. E. Holsten* and S. S. Craig*. Dept. of Anatomy, Med. Coll. of Va., Health Sciences Div., Va. Commonwealth Univ., Richmond, Va., 23219.

The widespread use of sequential renal biopsies has been of immense value to the detailed study of the fine structure and morphogenesis of glomerular lesions. The ultrastructure of the transplanted kidney in dogs is well documented but studies pertaining to man are relatively incomplete and rare.

The present investigation was undertaken to correlate the sequences of the clinical course of human homotransplants with the ultrastructural changes from anastomosis to nephrectomy.

It is generally believed that homografted tissue incites an immune response in the host which may ultimately lead to the destruction of the graft. Progressive cytoarchitectural changes which can be correlated with the clinical findings were observed in biopsies from 1 hour to the time of nephrectomy and can be listed as follows: 1) the endothelium appeared hypertrophied exhibiting arcing, blebs, deletion of pores and dilatation of the endoplasmic reticulum; 2) the pedicels of the podocyte showed degrees of fusion; 3) the basement membrane appeared edematous, dilated, irregular and exhibited densities and inclusions; 4) polymorphonuclear leukocytes infiltrated the glomerulus and various degrees of proximity of the PMN to the endothelial cells are found; and 5) fibrin and platelets were occasionally present. (Supported by U.S.P.H.S. grant A108150-01.)

FURTHER STUDIES OF THE ULTRASTRUCTURE AND FUNCTION OF THE THYROID GLAND OF THE GOLDEN HAMSTER - THE EFFECTS OF COLD EXPOSURE, THYROTROPIN AND PROPYLTHIOURACIL ADMINISTRATION. H. R. SEIBEL. Dept. of Anatomy, Med. Col. of Va., Health Sciences Div., Va. Commonwealth Univ., Richmond, Va. 23219

Some insight exists about the processes involved in thyroglobulin synthesis, but many steps are still unresolved. The morphological correlates of these processes: synthesis, storage, and reabsorption - release are even less understood.

In this study, golden hamsters were treated with propylthiouracil (PTU) (.05% in the diet); received TSH (1 unit for 5-30 days) and were exposed to cold (5-60 days at 5°C). Thyroidal ^{131}I uptake, measurement of PBI of thyroid homogenates and serum, chromatographic analysis of iodinated thyroidal proteins, colloid-cell ratios and pituitary cytology served as parameters.

After PTU there was an increase in the percent of MIT and a decrease of DIT, a decrease in the ^{131}I uptake, serum and thyroidal PBI¹²⁷, and percent of colloidal space. TSH and cold exposure led to an increase in ^{131}I uptake, serum and thyroidal PBI¹²⁷. TSH treatment resulted in an increase in the percent of cell ratio while after cold exposure percent colloid and cell did not vary from the normal. Hamster thyroid follicular cells possess ultrastructural features similar to those described for other species. Microvilli, Golgi complexes, the endoplasmic reticulum and apical vesicles appear to change significantly after the various treatments. Supported in part by A. D. Williams Fund # 3558-585.

IN VIVO EFFECTS OF HYDRAZINE ON LIVER PROTEIN METABOLISM. N. L. Smith* and W. L. Banks, Jr. Dept. of Biochemistry, Va. Comm. Univ.-Health Sci. Div., Richmond, Va. 23219

A time course study of the effect of a single subconvulsive dose of hydrazine to rats revealed that alterations in liver protein metabolism were greatest from 24 to 48 hours after the treatment. Significant elevations in liver wet weight, total protein and RNA contents, and the uptake of C^{14} -leucine into protein were demonstrated in hydrazine-treated animals compared to control animals, starting at 24 hours. Prior to 24 hours, significant, hydrazine-induced alterations in all these parameters were not observed. Hydrazine did not produce changes in liver total DNA content during the experimental period. When protein, RNA and C^{14} -leucine uptake were expressed on a DNA basis, the effects of hydrazine on these cellular constituents were described. Considered in terms of the total liver or the liver cell, the data were consistent with an hydrazine-induced net stimulation of hepatic protein biosynthesis which was maximal at 24 hours.

ANION PERMEABILITY OF ISOLATED FROG SKIN. T. C. Smith and E. G. Huf, Dept. of Physiology, Med. Col. of Va., Va. Commonwealth Univ., Richmond, Va. 23219

In recent years our laboratory has focussed interest on the mode of handling of CO_2 and HCO_3^- ion by isolated frog skin but the question of whether the non-glandular epithelium is permeable to, or can actively transport HCO_3^- is unanswered. Four types of studies on isolated belly skin of *R. pipiens* were carried out. 1) Na-solutions of HCO_3^- , Cl^- , SO_4^{2-} , NO_3^- (120 mEq/l) were replaced one by another in varying order. Only presence of Cl^- gave a low skin P.D. With HCO_3^- the P.D.'s were slightly lower than those with SO_4^{2-} . 2) Net inward HCO_3^- flux from a NaHCO_3 solution into an equivalent Na_2SO_4 solution was insignificant. Cl^- moved readily from a NaCl into a Na_2SO_4 solution leading to a reversal of skin P.D. 3) Skins in 110 mEq $\text{NaHCO}_3 + 10 \text{ mEq K}\text{HCO}_3$, pH 8, NaHCO_3 added to one side, were short circuited. The current drawn was equivalent to $1 \mu\text{eq cm}^{-2} \text{ hr}^{-1}$, i.e., the same as had the skin been kept in Cl^- Ringer's. Six times as much C exchanged, probably as CO_2 , at equal rates in the two directions. 4) For skins in HCO_3^- solution the skin P.D. changed by 24 mV per decade change in Na^+ at the epidermis. Similar low values occur for skins in SO_4^{2-} Ringer's. From these results it is concluded that the skin epithelium is highly impermeable to HCO_3^- . Furthermore, under the chosen experimental conditions the epithelial cells do not actively transport HCO_3^- ions. (Supported by NIH Grant 03545-17.

EVALUATION OF RADIATION QUALITY RELEVANT TO SPECIFIC BIOLOGICAL EFFECTIVENESS THROUGH CHARACTERISTIC RESPONSE DIFFERENCES IN SELECTED CHEMICAL AND PHYSICAL SYSTEMS. E. E. Stickley, Radiology Dept MCV/VCU, Richmond Va 23219

Response of chemical systems to irradiation is employed reliably to determine dose for clinical and research uses. The present study utilizes certain systems which were discarded because their yields depend upon type of radiation; color changes or increased optical density are related to the concentration of secondary ionizing particles released in characteristic relation to the type and energy of the source. The object is to record radiation field quality through individual, cooperating, or multi-step reactions which distinguish effects of low and high LET patterns. To depict (on a molecular basis) separate or combined events, detectors should be thin enough to exclude contributions from other events. Dilute solutions or thin films serve also to explore the changing characteristics of energy deposition across the Bragg region of heavy particulate radiations, in contrast with uniform effects in x-ray or electron beams. Substances used as detectors include ferrous-ferric solutions, Chalkley dyes, glasses, and crystalline slabs. Experiments with proton beams gave marginal data suggesting the anticipated effect in the dye systems. With x-rays and electrons, only typical uniform responses were seen. Further trials are planned with the highest intensities now available at the Space Radiation Effects Lab and MCV. Support by A.D.Williams Fund

A SOCIOLOGICAL SURVEY OF OSTEOMALACIA (A Pilot Study). B. Wynn-Davies* and H. R. Seibel, Dept. of Anatomy, Med. Col. of Va., Health Sciences Div., Va. Commonwealth Univ., Richmond, Va. 23219

Following the work of Chalmers and others, 831 geriatric and orthopedic patients in West London were reviewed for osteomalacia. History, relevant blood tests (calcium, phosphate, alkaline phosphatase, 24 hour urinary calcium) and radiology were assessed. Thirty-eight bone biopsies were performed. Thirty-three were positive (32 female, 1 male). Average age was 73.4 years. None had a history of gastric surgery. Twenty-eight were widows living alone. Three were sisters (spinster) living together. Twenty-two lived on their own property. Average weekly income was \$23.8. Average weekly food bill, \$3.1 (mostly bread, canned meat and canned fruit). The minimum for a balanced diet was thought to be \$6.5. Average milk consumption 2/3 pint per week. None of the patients cooked regularly. Twenty-six never cooked at all. None had sought the assistance of any of the welfare organizations, either through pride, ignorance or apathy. All showed subjective and objective improvement following Vitamin D supplementation and dietary improvement.

ARTIFICIAL INSEMINATION OF THE CAT. N.J. Sojka,* Reproductive Biology Lab., and Vivarium, U. of Va., Med. Sch., Charlottesville, Va., 22901 (sponsored by C. E. Hammer).

Techniques for artificial insemination of cats have been developed in this laboratory. Semen is collected from toms with an artificial vagina using an estrus queen as a teaser. A typical ejaculate contains 0.04 ml seminal plasma with 57×10^6 sperm. Motility of the sperm range from 80-90%. Cytoplasmic droplets and club tails are the most frequent abnormalities making up 3-5% of the total sperm. The ejaculate is diluted with saline to 1.0 ml and 0.1 ml of this sample is deposited into the anterior vagina or posterior cervix of an estrus queen. The queen is then induced to ovulate with 50 i.u. of HCG intramuscularly. The procedure results in 42% pregnancies. If the queen is inseminated a second time 24 hours after the first insemination and an additional 10 i.u. of HCG 71% pregnancies occur. (Supported by Morris Animal Foundation)

A REEXAMINATION OF THE THEORY OF THE TRANSIENT ELECTRO-OPTIC KERR EFFECT. A. Kent Wright, Dept. of Biophysics, Med. Col. of Va., Richmond, Va.

In comparing the information obtained from measuring the transient Kerr effect with that obtained from depolarization of fluorescence, with respect to rotational diffusion of ellipsoids of revolution, it is found that the Kerr effect contains only half the information as the other theory. A reexamination of the theory of the transient Kerr effect reveals that the theory derived by H. Benoit, for the case of ellipsoids of revolution, is less general than was previously believed. In fact, Benoit derived the theory for the case of spheres, mistakenly. The corrected theory for the case of ellipsoids of revolution removes the above discrepancy and therefore doubles the information obtained from the transient electro-optic Kerr effect. (Supported by an NIH predoctoral training grant and the Defense Atomic Support Agency).

THE RELATION BETWEEN CELL REPLICATION AND OVERT DIFFERENTIATION IN THE EARLY CHICKEN LENS RUDIMENT. J. Zwaan, Dept. of Anatomy, Univ. of Va., Charlottesville, Va. 22901.

Specific antisera were used to study by immunofluorescence the appearance of alpha- and delta-crystallin in the embryonic chick lens. Contrary to older reports alpha-crystallin was first detected relatively late, at 3-3.5 days of incubation, in centrally located lens fibers. At 6 days the epithelium began to react. In the intermediate placode (52 h.) delta-crystallin was present. The fluorescence gradually spread until at 3 days the entire lens was positive.

Autoradiographs after ^3H thymidine application showed that lens cells are still replicating until the early lens cup stage, after which DNA-synthesis ceases in the prospective fibers. Cell replication in the epithelium does not become restricted to a germinative zone until much later in the embryonic period.

I conclude from these two sets of data, and from the observation of specific fluorescence in dividing cells, that lens cells need not be in their terminal cell cycle (permanent G₁ phase) to initiate synthesis of the crystallins. (Supported by grant no. GB-3236 from the National Science Foundation and by grant-in-aid no. G-353 of Fight-for-Sight, Inc., New York.)

Section of Microbiology

Forty-Seventh Annual Meeting of The Virginia Academy of Science
May 8-10, 1969, Fredericksburg, Virginia

ENHANCEMENT OF L-ARABINOSE UTILIZATION BY AN EXTRAGENIC MUTATION IN *ESCHERICHIA COLI*
B/r. Robert G. Bost^{*} and R. M. Cribbs. Department of Genetics, Med. Col. of Va., Richmond, Va. 23219

An unusual revertant of an L-ribulokinase structural gene mutant has been isolated. Growth studies and transduction analyses indicate that the revertant contains two mutations. One of the mutations is in the L-ribulokinase structural gene at or near the site of the original mutation. This reversion permits partial utilization of L-arabinose. The second mutation is outside the L-arabinose operon and enhances L-arabinose utilization by the revertant containing the intragenic mutation. Enzyme assays show that the extragenic mutation acts by increasing the rate of translation of the L-arabinose operon which contains the intragenic reversion. The extragenic mutation probably increases the quantity of a species of soluble ribonucleic acid that is complementary to the codon of the intragenic reversion. The net result, then, is an increased translation of the polycistronic messenger ribonucleic acid of the L-arabinose operon into protein.

AN EVALUATION OF METHODS PREDICTING SUSCEPTIBILITY TO DENTAL CARIES. D. L. Everhart*, P. B. Sobel*, and W. H. Carter, Dept. of Microbiology, Dept. of Pedodontics and Dept. of Biometry, Med. Col. of Va., Richmond, Va. 23219

Snyder index values, lactobacillus counts, and saliva concentrations of immunoglobulin A (IgA) were compared to the active and past dental caries activities of 44 individuals (mean age 14.6 yr). Clinical evaluation of caries activities was based on the number of missing teeth and the number of caries-involved surfaces of remaining teeth. A semi-quantitative single diffusion gel method using anti-human IgA was employed to measure saliva concentrations of the immunoglobulin. Snyder index values, lactobacillus counts, and IgA concentrations were statistically evaluated by linear regression analysis for correlation with the clinically recorded caries activities. Only a correlation between lactobacillus counts and caries activities was obtained. In contrast to previous reports, no relationship between IgA or the Snyder index and dental caries activities was observed. (Aided by General Research Support Grant, School of Dentistry, FR534508)

STUDIES ON R FACTOR DNA. D. J. Kopecko* and J. D. Punch, Dept. of Microbiology, Med. Col. of Va., Richmond, Va. 23219

To obtain R factor harboring *Proteus mirabilis* for this study, an efficient technique for enriching the *P. mirabilis* recipients was developed. After mating 24 hr in Penassay broth, followed by 24 hr enrichment in KCN broth, *P. mirabilis* recipients which had acquired the R factor (transcipients) were selected on MacConkeys agar + 25 µg/ml Colymycin + 20 µg/ml of an antibiotic to which the R factor conferred resistance. During transfer of R factor 222 from *E. coli* K-12 substrain CS12 to *P. mirabilis*, two types of transciptiens were obtained; one showing the characteristic resistance pattern of 222 (Cm Sm Tc Su) and another resistant to Km Nm Sm Tc. DNA was extracted and subjected to density gradient centrifugation in CsCl at 44,000 rpm. DNA from *E. coli* or *E. coli* (Cm Sm Tc Su) gave only one peak (density 1.709 or 50% G+C). *P. mirabilis* DNA formed a density peak at 1.697 corresponding to 38% G+C. In addition to this peak, *P. mirabilis* (Cm Sm Tc Su) DNA showed two peaks; one at p=1.706 or 49% G+C, the other at p=1.720 or 61% G+C. In contrast, *P. mirabilis* (Km Nm Sm Tc) gave only one satellite DNA band (p=1.714 or 51% G+C). When *P. mirabilis* transciptiens were mated with *E. coli* (R^r), only *E. coli* (Cm Sm Tc Su) transferred the R factor to the *E. coli* recipient. Thus, phenotypic loss of Cm and Su, and the acquisition of Km and Nm resistance in the *P. mirabilis* (Km Nm Sm Tc) isolate was concomitant with loss of one density peak (p=1.720 or 61% G+C) and R factor transferability.

RETARDATION OF SPARSOMYCIN-ENDOTOXIN SYNERGISTIC TOXICITY BY MEDROL. W. C. Rose* and S. G. Bradley. Dept. of Microbiology, Med. Col. of Va., Richmond, Va. 23219

Sublethal doses of the antitumor antibiotics sparsomycin and pactamycin act synergistically with bacterial endotoxin to produce ocular hemorrhage and sometimes death in treated mice. Because this observation may have clinical significance, various agents have been tested for ability to prevent this effect. When used prophylactically, 100 mg 6 α-methyl prednisolone/kg (Medrol) was found to retard the toxic effect of the sparsomycin and endotoxin combination. The 6 α-methyl prednisolone was ineffective in the tested concentrations against the pactamycin-endotoxin synergistic toxicity. Also ineffective against the pactamycin-endotoxin combination was the antihistamine chlorpheniramine maleate and the anti-inflammatory agent phenylbutazone.

NUTRITION OF PHLYCTOCHYTRIUM SP. Gilbert S. Trelawny. Dept. of Biology, Madison Col., Harrisonburg, Va. 22801.

Carbohydrates, amino acids, peptones, proteins, some Krebscycle intermediates, and a few miscellaneous organic compounds were provided individually in a mineral base as the sole source of carbon and/or nitrogen. The degree to which growth was supported by these substrates was evaluated in terms of dry weight of the fungal growth.

Carbohydrates functioned as a more readily available source of carbon than did the other substrates offered. Utilization of amino acids was limited and none were used as the sole source of both carbon and nitrogen. Growth on peptones and proteins was enhanced by the addition of glucose. Krebscycle intermediates did not support growth.

Section of Psychology

Forty-Seventh Annual Meeting of The Virginia Academy of Science
May 8-10, 1969, Fredericksburg, Virginia

PERCEPTION OF FACTORS CONTRIBUTING TO THE HARD-CORE UNEMPLOYMENT PROBLEM. S. B. Burnette, G. M. Leigh, and A. L. Cone. Dept. of Psychology, Lynchburg Col., Lynchburg, Va. 24504

54 Ss in six occupational categories completed a paired-comparison questionnaire which included 16 factors derived from HEW-Labor's definition of a hard-core unemployed person. Inter-judge reliabilities were found to be significant within all occupation groups. Using Torgerson's Class II, Condition C for Comparative Judgments with incomplete X matrix each of the 16 factors was scaled for each group. It was found that Community Action workers' perception of factors contributing to hard-core unemployment correlated significantly only with the scaled values of academic sociologists. Of the remaining groups the obtained scale values inter-correlated significantly except in the case of plant foremen and academic sociologists. It is clear that those people (CA workers) closest to the true hard-core unemployed do not perceive the variables contributing to unemployment in the same way as those people who are currently engaged in local industry at any level.

EFFECTS OF PUNISHMENT OF A TWO-LEVER SHOCK-ESCAPE RESPONSE. Dianne Buttry* and R. Chris Martin, Hollins College, Va. 24020.

Rats were trained to press two bars, sequentially, to escape pulsed shock. The left bar was extended first; extension of the right bar was contingent on Ss hitting the left bar. Hitting the right bar turned off shock and terminated the trial. A within subjects design involving the following treatment conditions was used: acquisition, non-punished extinction, retraining, punished extinction, re-training. Half of the Ss received non-punished extinction first; the other half received punished extinction first. A tone was paired with the pulsed shock, and was used independently of the shock in extinction sessions. Results showed an order effect: if non-punished extinction was first, Ss ran for more trials during non-punished extinction than during punished extinction; if punished extinction was first, Ss ran more trials during punished extinction than during non-punished extinction. This last occurrence is evidence of vicious circle behavior, which is defined as greater resistance to extinction of punished Ss over non-punished Ss. The authors interpreted the data within the framework of theoretical explanations of self-punitive offered in runway situations.

EFFECTS OF AMBIENT ILLUMINATION CONDITIONS ON WATER INTAKE IN ALBINO RATS: A PRELIMINARY REPORT. M. J. Carow and Donna M. Cone, Dept. of Psychology, Lynchburg Col., Lynchburg, Va. 24504

The water consumption of 12 albino rats, 7 males and 5 females, was measured daily. From 25-119 days of age four Ss lived in individual cages under each of the following conditions: (A) 24-hr. dark in sound-treated booth; (B) LD 12:12 (2 1/2-6 ft-c) in sound-treated booth; (C) LD 12:12 (2 1/2-13 ft-c) in colony room. The mean daily water intake for the 30-day period between 89 and 119 days of age was: (A) 48.91 ccs.; (B) 55.97 ccs.; (C) 46.46 ccs. Conditions were then switched during the following two 30-day periods and it was found that only Condition A Ss (those raised in 24-hr. dark) responded markedly to shifts in ambient sensory input. The mean daily intake of these Ss increased to 72.66 ccs. when placed under Condition B (119-149 days of age) and then decreased to 62.19 ccs. when placed under Condition C (149-179 days of age). The differential effects of ambient sensory input on adult rat water intake is discussed in terms of Bindra's arousal hypothesis and possible changes in the responsiveness to arousing stimuli as a function of early environment.

ATTEMPT TO CONFIRM ASCHOFF'S RULE FOR A FREE OPERANT: FAILURE AND SERENDIPITY. A. L. Cone, Dept. of Psychology, Lynchburg Col., Lynchburg, Va. 24504

Three albino rats were trained in a Skinner Box on a VI-3 schedule of reinforcement with water as the reinforcer in an attempt to extend Aschoff's rule to free operant lever pressing. Food was available ad libitum. Ss lever pressed for water on the VI-3 in constant darkness for 60 days. Body weight stabilized and remained constant during this 60 days. In addition all Ss demonstrated nocturnal cyclic behavior of about 23 1/2 hours duration and approximately in phase with the external environment.

Constant illumination of 30 lux was then introduced for 4 days. The length of circadian cycle was not increased as predicted. There was, instead, an almost complete suppression of responding. A four day reinstatement of darkness returned responding to its pretreatment levels. During a second four days of constant illumination at 5 lux there was again response suppression and one of the Ss died from dehydration. Response rates returned to baseline with a second four days of darkness. During the final constant illumination period (5 lux) a second S died and the experiment was terminated.

MOOD CHANGE DURING INITIAL PERIOD OF REHABILITATION OF ALCOHOLICS. K. C. Corley, Jr., and A. Herrick*, Dept. of Physiology and Bureau of Alcoholic Studies and Rehabilitation, Health Sciences Div., Va. Commonwealth Univ., Richmond, Va. 23219

In rehabilitation of alcoholics, mood is a psychological parameter that has been reported to change during the initial period of alcohol withdrawal. These mood changes have, however, been primarily clinical observations and not verified by objective testing. In the present investigation, the Nowlis-Green Mood Adjective Checklist (short form) was used to assess mood fluctuations. 30 hospitalized alcoholic patients were tested daily over six days to describe mood changes at various stages of rehabilitation. These data indicated that while categories of social affection, egotism, and sadness were unchanged, aggression, surgency, anxiety, concentration, and fatigue were affected. Comparison between the first and subsequent hospital days revealed that these effects were most pronounced between Day 1 and Days 4 and 5 ($p < .01$). Between Day 1 and 4, surgency and concentration self-ratings were increased while anxiety and fatigue decreased. Aggression ratings were also affected with a decrease between Day 1 and 5. Because these mood changes persisted at least through Day 6 in these patients, these changes were possibly due to hospitalization. Further research will be necessary, however, to determine if these effects can be ascribed to therapy.

SINGLE UNIT NEURAL RESPONSES FROM TWO-FREQUENCY VIBRATORY STIMULATION OF A CUTANEOUS MECHANORECEPTOR IN THE CAT: THE PINKUS HAIR DISC. Roger W. Cholewiak, Dept. of Psychology, Univ. of Va., Charlottesville, Va. 22901

The Pinkus hair disc is a well-defined cutaneous mechanoreceptor in the cat's hairy skin. Past work has studied the patterning of neural responses of the disc to simple mechanical stimulation of various types (eg., sine waves, square pulses). The present study examined the responses of this receptor to the cutaneous analog of auditory masking.

Receptor thresholds of 40-50 μ were obtained for 20, 35, 50, 65, and 80 hz. stimulation, with sensitivity inversely proportional to frequency. Fifty hz. stimulation was then presented to the receptor at 2 or 4 times its threshold intensity, electronically mixed with each of the other frequencies. The threshold increase found for the second stimulus was inversely proportional to its frequency and directly proportional to the 50 hz. stimulus intensity. The shift can be predicted from the intensity (in spikes evoked/second) of the 50 hz. stimulus and from the second-frequency rate functions. Results were discussed in terms of the type of neural coding of the complex stimulus suggested by the correlation between the stimulus and the response.

(Supported by NIH Grant NB 0744602 to J.F.Hahn.)

CAGE ACTIVITY IN RECENTLY WEANED ALBINO RATS, GUINEA PIGS AND WILD RABBITS. Donna M. Cone and A. L. Cone, Dept. of Psychology, Lynchburg Col., Lynchburg, Va. 24504

Earlier research from the Lynchburg College Psychology Department laboratories has demonstrated that the effects of time of day and level of illumination upon cage activity are not independent for the nocturnal opossum and the diurnal antelope ground squirrel. The present research extends these findings to newly weaned wild rabbits, guinea pigs, and albino rats. All species were run in IVE activity cages under LD 12:12 except that a special test illumination condition (Dark, 1, 2.5, 5, 25 or 50 ft-c) was introduced from 10-12 a.m. and 10-12 p.m. Although the functional relationships differ, all species exhibit a significant change in activity depending on the time of day, a significant change as a function of level of illumination, and a significant interaction effect for illumination and time of day. In addition all species showed a significant effect of increasing age which was not independent of the test level of illumination. Speculative interpretations are offered as to the role of sensory input in developing species-specific behavioral cycles.

PREDICTING ACADEMIC ACHIEVEMENT IN A SPECIAL COLLEGE POPULATION USING THE STRONG VOCATIONAL INTEREST BLANK. L. Burke Crowder, Dept. of Psychology, Univ. of Richmond, Va. 23173

The SVIB was administered to approximately 200 college students who had been admitted to University College with poor high school records. One hundred of these were chosen at random for this study. The Academic Achievement Interest Scale score was compared with grade point average and CEEB verbal scores for each student. Eighty of the 100 chosen met the criterion (all three scores being available). The median academic achievement score was 44 with half of the students falling at or below 44 and half above. The range was 17-73. The mean grade point average of the lower group was 1.8 and that of the upper group 2.4 on a 4-point scale.

FACILITATION OF PAIRED-ASSOCIATE LEARNING FOLLOWING GROUP EXPOSURE TO THE RESPONSE ITEMS. Richard W. Davis*. Dept. of Psychology, Univ. of Richmond, Va. 23173

Sixteen high and low category association words were presented either alone as part of an S - R pair (single exposure), or in a response category of 4 words (group exposure) to an unrelated stimulus word. Under single exposure 29 Ss viewed each pair for 10 seconds; under group exposure 35 Ss viewed each category for 40 seconds. Total viewing time for both conditions was 160 seconds. The Ss were immediately tested for recall by providing the correct response word to the appropriate stimulus word.

A 2 X 2 design revealed that group exposure produced significantly higher recall over-all and with high but not with low association words. High category association words yielded significantly higher recall under all exposure conditions. These data are empirical evidence that group exposure of related response terms facilitates paired-associate learning.

SWEETNESS PREFERENCE IN CALIFORNIA ANTELOPE GROUND SQUIRRELS. J. D. Giddens and A. L. Cone. Dept. of Psychology, Lynchburg Col., Lynchburg, Va. 24504

Sweetness preference was determined for nutritive and non-nutritive liquids using 10 California Antelope Ground Squirrels as Ss. Solutions for the nutritive conditions were 0, 4, 8, 16, and 32% sucrose. Solutions for the non-nutritive conditions were 0, 0.5, 1, 2, and 4% calcium cyclamate. These values were computed from the manufacturer's equal-sweetness-to-sugar-concentration data. Significant preferences were found for the sugar solutions with 8% being the most highly favored. There were no significant differences among the levels of the artificial sweetener. It is concluded that sweetness preference in these ground squirrels is based upon caloric intake rather than gustatory input.

AVOIDANCE BEHAVIOR IN A LEVER-PRESS SITUATION. Phillip Goldstein* and R. Chris Martin, Hollins College, Va. 24020

The efficacy of three avoidance paradigms were compared with a regular avoidance paradigm. The main experimental condition for the three groups involved a situation in which only avoidance responses were possible. Failure to avoid resulted in a brief inescapable shock. Prior to initiation of the "avoidance only" condition, one group was given a series of classical conditioning trials of tone and shock with the isi equal to the avoidance latency. Another group was given a series of escape trials prior to the "avoidance only" condition, and the third group was given "avoidance only" conditions entirely. The results showed that the regular avoidance group was superior to the other three groups. The results are discussed in terms of nature of response required, nature of responses elicited by fear, and are compared with data obtained in shuttle-box avoidance studies.

WEIGHT REGULATION BASED ON RATE OF WEIGHT GAIN IN THE HYPOTHALAMIC HYPERPHAGIC RAT. R. Curtis Graeber*, Dept. of Psychology, Univ. of Va., Charlottesville, Va. 22903

Hypothalamic hyperphagia consists of two phases: a dynamic phase of rapid weight (wt.) gain followed by a static phase of high asymptotic wt. level. This study examined the nature of wt. gain in dynamic hyperphagia and of static wt. loss caused by decreased palatability of static animals' diets.

Dynamic hyperphagic rats were forced to lose wt. by giving them an aversive tasting solution as the only source of fluid for various 24-hr. periods. Within one day after normal fluid restoration, Ss gained more wt. than they had lost and weighed what would have been predicted from their pre-deprivation rate of gain. If a highly palatable solution were given instead of an aversive one on the probe day, Ss gained to a wt. above the dynamic slope and then returned to the slope on the restoration day. High and low palatability fluid probes were also given to previously static Ss losing wt. on a low palatability diet. Normal fluid restoration again resulted in a return to the slope, this time describing wt. loss. These findings suggest that dynamic hyperphagics gain wt. at a fixed, but less than maximal, rate and that static wt. loss also occurs at a somewhat fixed rate.

CONDITIONED CONCENTRATION - MEMORY AND REASONING UNDER SENSORY BOMBARDMENT. D. B. Hagan*, J. V. Naselli*, & T. J. Rahm*. Dean Foster, Dept. of Psychology, Va. Military Inst., Lexington, Va. 24450.

Preliminary observations indicated that a subject confronted with a situation of sensory bombardment would soon desire to escape from these controlled conditions of intense stimuli. Sensory bombardment was produced through a total, random, meaningless engagement of the major senses. Taken together the stimuli were beyond normal sense comprehension.

The lack of coherent order and meaning in addition to the intensity of the stimulus appeared to produce "mental retreat," an attempt by the subject to retain orientation.

How does the subject react to or cope with prolonged sensory bombardment? It was our theory that the subject under S.B. would become conscious, not of separate and meaningful sensations but of a single, all pervasive distraction. At this time he would seize upon some means to relieve this distraction.

From this we formulated our hypothesis that a subject who is exposed beyond a full engagement of his senses under sensory bombardment will be able to concentrate more effectively and hence score significantly higher on memory & reasoning tests than under normal study conditions.

Data acquired from 20 subjects supported the contention that memory (tested through nonsense syllable retention) was significantly improved while reasoning was not.

MULTI-TEST, MULTI-TRAIT ANALYSIS OF MATURITY. Willard Orrin Hall*, Dean Foster, Dept. of Psychology, Virginia Military Institute, Lexington, Va. 24450

Maturity is an ambiguous term for describing personality. Still, for young adults, we found general agreement about its use in categorizing roommates and close friends. Hence this study started with the Bender-Gestalt Drawing Test because it purports to measure a child's maturation level. Why has it been avoided with older persons? Also, what traits might a mature adult have?

To answer this question and to better define this trait, we applied additional tests (Strong, Edwards, and a questionnaire of experience plus another rating-self rating instrument) to a sample of college sophomores. Since none of these additional tests measured maturity, we assumed that patterns of scores might yield correlations of consequence, especially where grades, College Board scores, or drop outs were considered.

From initial comparisons, a "standard" of maturity was derived and is described. It weights traits in accordance with their importance to the total working concept. One case is employed as an illustration of this application.

The most accurate predictors of this trait, and therefore a key part of the "standard" are prescribed levels of achievement, deference, heterosexuality, aggressiveness, and dominance.

DRINKING INDUCED BY MANIPULATION OF BLOOD VOLUME AND TONICITY IN WEANLING AND ADULT RATS. *Frederick J. Kozub*, Dept. of Psychology, Univ. of Richmond, Va. 23173.

The present study was performed to determine whether weanling rats drink in response to direct manipulation of the volume and tonicity of the blood. Comparisons in fluid intakes were made with adult animals. Two groups, 16 adults (90 days of age) and 16 weanling rats (25 days of age--weaned at 23 days) were each divided into four groups of four Ss each. After 24 hrs. of food and water deprivation Ss were injected subcutaneously with polyethylene glycol, formalin, 6.0% NaCl or .9% NaCl.

No qualitative differences were found in water intake in either group. The effectiveness of thirst inducing stimuli for both groups was ordered thusly (highest to lowest): 6.0% NaCl, formalin, polyethylene glycol, .9% NaCl.

Although some physiological differences exist in the mechanisms controlling fluid content of the body between young and adult animals, these mechanisms did not seem to be potent enough to manifest themselves in the behavior of the young organism.

A RE-EVALUATION OF THE LENGTH-DIFFICULTY RELATIONSHIP. *Russell L. Leonard**, Dept. of Psychology, Univ. of Richmond, Va. 23173.

The purpose was to show that task difficulty increases linearly with task length. Two groups of 20 general psychology students were given 7 trials, 2 minutes apart, on the Lafayette card sort apparatus. Group Task-Length (T-L) used 2 sets of 5 cards (2 different numbers) on trial 1, and 14 sets on trial 7. Group Length (L) used the same number of cards on each trial but kept the same 5 numbers throughout. Ascending and descending series were used within each group.

A trend analysis revealed significant quadratic and linear components for group T-L, but only a significant linear component for group L. It was concluded that when the nature of the task is held constant, there is a strictly linear relationship between task difficulty and task length. It was suggested that the earlier experiments, which found that task difficulty increased at a disproportionately faster rate than task length, varied not only the length of the task but the nature of the task.

SOME MATTERS OF TASTE. *D. G. Mook**, Dept. of Psychology, Univ. of Va., Charlottesville, Va. 22901.

In rats, the role of taste in the control of ingestion may be investigated by holding postingestive events constant, while varying the material presented to the mouth. Taste stimuli in isolation have profound effects on ingestion. These effects are not fixed, however, but operate in interaction with other factors. Both the short-term consequences of ingestion, and long-term changes in the state of the internal environment, modify the response to a given taste stimulus. (Aided by PHS grant MH 10766)

CHILDHOOD AUTISM: A CRITICAL REVIEW OF EXPERIMENTATION. *Lynda Beran Murray**, VA Hosp., Salem, Va. and Frank S. Murray, Dept. of Psychology, Randolph-Macon Woman's Col., Lynchburg, Va. 24504.

According to Kanner, the pathognomonic symptoms of early infantile autism are (1) extreme aloneness (inability to relate to people) "from the beginning of life" and (2) an obsession for maintaining sameness. Experimentation using autistic children as subjects was categorized into (1) drug research, (2) operant conditioning techniques, (3) neurophysiological investigations, and (4) miscellaneous studies. Of these, operant conditioning techniques were the most extensively used. Drug studies were incomplete and poorly designed; no firm conclusions could be derived from these studies. Operant conditioning techniques showed that autistic children did not have any basic deficits in learning except in the rate at which they acquired new responses. Neurophysiological evidence suggested some involvement of the reticular formation producing high physiological states of arousal, although this finding was not consistent in the literature. Suggestions for further research include using larger numbers of subjects, using subjects that have not been involved in previous research, employing some measure of response generalization outside the experimental environment, and measures of long-term effects.

SELF-PACED INSTRUCTION: THEME, VARIATIONS AND RESULTS. *J.R. Nazzaro** (Sponsored by E. K. Dodd), Department of Psychology, Mary Washington College of the University of Virginia, Fredericksburg, Virginia, 22401.

108 students participated in an experimental self-paced course designed to teach the principles of general psychology. The technique was devised by F.S. Keller and was based on reinforcement theory. The subject matter for the course (a standard introductory text) was broken down into 40 small, chapter-size units. The student was provided with an extensive list of study questions. When the questions were mastered for the unit, the student presented herself for a short exam. Perfect papers were required to pass the unit and any errors necessitated retaking alternate exams. Correct answers were immediately reinforced and incorrect answers were explained. The student moved through the course as fast as she could.

A posteriori comparisons showed that recall based on a final exam of multiple choice items was significantly better in the self-paced group than in regular lecture sections ($t=6.12$, $df=139$, $p<.01$). A further multiple choice test given 5 weeks after completion of the course showed that the self-paced sections scored significantly higher ($t=2.76$, $df=30$, $p<.01$) than a random sample taken from the lecture sections. (Aided by a small grant from Mary Washington College of the University of Virginia)

"EDUCATION" AS A MNEMONIC DEVICE. *James R. Pash**, Dept. of Psychology, Univ. of Richmond, Va. 23173.

This experiment investigated the effect of the utilization of a mnemonic device on the retention of verbal material. Two serial lists, one with 9 high-m disyllables and one with 9 low-m disyllables taken from Noble's (1952a) m-scale, were prepared. The initial letters of the 9 items in each list could be arranged to spell "education." This was the mnemonic device, which was demonstrated only to the experimental group. The Ss were given 5 minutes to memorize one of the two lists. Each list was used by approximately the same number of Ss within each group, experimental (n=56) and control (n=40).

After 48 hours, no significant retention difference was found between the two groups, either for high-m or low-m lists. It was concluded that an experimental design that forces the Ss to utilize the mnemonic device would produce significantly superior retention.

INFLUENCE OF EGO INVOLVEMENT ON DISCRIMINATION IN THE CONSTRUCTION OF ATTITUDE SCALES. M.K. Phifer*. Dept. of Psychology, Mary Washington Col. of U.Va., Fredericksburg, Va. 22401

The study investigated effects of ego involvement in discrimination of attitudinally related items in construction of attitude scales. Individuals were given an opportunity to select statements for an attitude scale in order to investigate effects of ego involvement on placement of items within latitudes of acceptance, rejection and noncommitment. Subjects allotted a greater proportion of statements to their own latitude of acceptance than to latitudes of rejection and non-committment. Discrimination was finer within latitudes of acceptance than within latitudes of rejection and noncommitment.

CHARACTERISTICS OF UPPERCCLASS WOMEN AT R-M-W. Frederick B. Rowe, Wendy Davidson, and Barbara Noel, Dept. of Psychology, Randolph-Macon Wom. Col., Lynchburg, Virginia 24501

One of the newer areas of investigation in social and educational psychology is institutional research, including emphasis on student perceptions of their college environment.

Robert Pace and George Stern were among the first to conduct studies in this area; these studies led to their development of the College Characteristic Index. Pace later developed the College and University Environment Scales (CUES).

The purpose of this paper is to examine the perceptions of Randolph-Macon upperclass women as measured by the newest of these instruments, the Questionnaire on Student and College Characteristics (QSCC), published in 1968.

As a possible means of validation, the data of the QSCC has been compared with the results of CUES.

THE BEGINNING OF EXPERIMENTAL PSYCHOLOGY IN THE SOUTH. Frederick B. Rowe, Cora L. Friedline, and Frank S. Murray*, Dept. of Psychology, Randolph-Macon Wom. Col., Lynchburg, Va. 24504

A review of the history of experimental psychology in the United States indicates that the late 1800's marks the turning point from a traditional psychology within philosophy to an experimental psychology.

The literature of psychology offers little or no information regarding the establishment of experimental psychology south of Washington.

The purpose of this paper is to correct the record by noting the establishment of the oldest continuous laboratory in the South, i.e., the laboratory founded in 1893 at Randolph-Macon Woman's College by a Titchener protege, Prof. Celestia S. Parrish, and to describe the people and the facilities with which they operated in the last decade of the Nineteenth and the first decades of the Twentieth Century.

AN EXPERIMENTAL INVESTIGATION OF PAIN BY THERMAL STIMULATION Judith F. Safferstone*, and Frank S. Murray, Dept. of Psychology, Randolph-Macon Woman's Col., Lynchburg, Va. 24504

Pain threshold and tolerance in preferred and non-preferred hands were measured in 41 female Ss by the method of cold water bath stimulation. Prior to each experimental trial, Ss placed their hands in an adapting bath of 32°C. ($\pm 1.0^\circ\text{C}$) for two minutes; and their judgments of the temperature of this water -- as rated on a 200-point scale ranging from -100 (extremely cold) to +100 (extremely hot) in ten-point intervals -- were recorded every thirty seconds. The Ss then immediately placed their hand(s) into the cold water bath of 2.0°C, where measures of pain threshold and tolerance were recorded. Pain threshold was defined as the time when Ss first gave a verbal report of pain. The measure of tolerance was the entire duration the Ss maintained their hands in the cold bath. Ten trials per S were administered -- five for the left and five for the right hand. Statistically significantly longer durations for both threshold and tolerance were obtained for the preferred than the nonpreferred hand.

ATTEMPTS BY TRANSFORMATION OF PREDICTOR VARIABLES TO IMPROVE PREDICTION OF FRESHMAN GPA. A. A. Slaymaker and A. L. Cone. Dept. of Psychology, Lynchburg Col., Lynchburg, Va. 24504

A careful examination of scattergrams prepared on standard predictor variables (SAT-V, SAT-Q, and High School Average) suggested that the functional relationship was not truly linear. Two methods were used in an attempt to improve linearity: (a) transformation of predictors for exponential and logarithmic functions and (b) inclusion of two motivational scales, the Crowne-Marlowe Social Desirability Scale and the Internal-External Control Scale.

Regression analysis using all combinations of the criterion variables with untransformed and transformed data was run. No significant improvement was found in the multiple correlation coefficient by the introduction of either motivational scales or the transformations. Analysis of variance indicated that there were no significant deviations from linearity even for untransformed data.

STORAGE AND RETRIEVAL PROCESSES IN LONG-TERM MEMORY. Anderson D. Smith, Dept. of Psychology, Univ. of Va., Charlottesville, Va. 22903

A recognition task was used to empirically separate storage and retrieval processes in long-term memory. Free recall (FR) can be interpreted as involving two components: first, retrieval from memory using an organizational cue, and second, recognition of the retrieved item as appropriate for output. In a recognition task, the words are presented to the S and the retrieval component is not necessary. Therefore, any decrement in recognition performance suggests deficiencies in storage and not retrieval. Presentation time (PT), list length (LL), and output task were examined with a $2 \times 2 \times 2$ factorial design. A significant effect of PT was found in both FR and recognition while LL affected only FR. Since differences due to the PT manipulation occurred in both FR and recognition, increasing the PT of the item at input appears to have an effect on the storage of the item rather than retrieval. Because differences due to LL were not found with the recognition task, however, LL was interpreted as affecting retrieval from long-term memory rather than storage.

A COMPARATIVE STUDY OF VIET NAM PROTESTERS AND NON-PROTESTERS. N. J. Soltz; J. J. Ewell; M. D. Chesser, Old Dominion College, Norfolk, Virginia 23505

A group of 9 students actively engaged in the protest of the Viet Nam war and a group of 9 students not actively engaged in protest activity were administered the following psychological tests: WAIS, KTS, MMPI, and SVIB. On the basis of these tests it was determined that while no significant difference in IQ existed between the groups, the protesters manifested higher levels of anxiety, displaced needs for accomplishment and dependency, and showed a tendency to withhold insightful solutions to problems for fear of repudiation. The protest group in addition showed an overly judgemental attitude. It was concluded in this area to reduce high variances due to the small size of the groups.

THE EFFECT OF PRIOR KNOWLEDGE AND DISENGAGEMENT ON THE RETENTION OF A SIMPLE PSYCHOMOTOR TASK. Stephen D. Southall* and Kenneth A. Blick. Dept. of Psychology, Univ. of Richmond, Va. 23173

The purpose of this experiment was to test for the effect of prior knowledge and disengagement on the retention of a simple psychomotor task. A Knowledge (K) group knew before they made their first dialing response (R_1) that they would have to repeat it (R_2) 48 hrs. later, and the No Knowledge (NK) group did not know until after they made R_1 that they would have to repeat it. Following R_2 , both groups were guided through a response (R_3); the Disengaged (D) group was disengaged from the seated position for 20 sec. while the Not Disengaged (ND) group remained seated. Two min. later all Ss attempted to duplicate their response (R_4).

An analysis of correlations, means, and variances yielded no significant differences for any comparisons in either experiment. The variables of prior knowledge and disengagement had no effect on retention possibly because of the simplicity of the task employed.

THE RELATIONSHIP BETWEEN SELF-CONCEPT AND MANIFEST ANXIETY. Daniel Stern*. Dept. of Psychology, Univ. of Richmond, Va. 23173

The present study was performed to determine the correlation between 2 measures of self-concept and manifest anxiety. The Tennessee Self-Concept Scale (TSCS), the Gibby Intelligence Rating Schedule (IRS), and the Taylor Manifest Anxiety Scale (MAS) were administered to 68 introductory psychology students. The results of a series of Pearson product-moment correlations indicated that the higher the manifest anxiety the lower the overall level of self-esteem ($r = -.70$), the higher the total conflict in self-perception ($r = .49$), and the higher the variability in ratings in self-perception of intelligence ($r = .44$). These correlations were significant at the .01 level. The correlations between various other scales on the TSCS and IRS were discussed.

TIME-OUT FROM POSITIVE REINFORCEMENT AS PUNISHMENT FOR CHOICE BEHAVIOR. J. C. Todorov* (sponsored by E. K. Dodd), Mary Washington College, Fredericksburg, Va. 22401

Key-pecking behavior of three pigeons was observed in a two-key standard experimental chamber in which the Ss had an option to emit either of two incompatible operants. Independent variable interval (VI) schedules assigned reinforcements for each operant. Pecks at the left key (changeover key), always white, changed the color on the right key (main key) to red or green. Pecks at the main key were reinforced under a VI 1-min schedule when the key was red, and under a VI 3-min schedule when the key was green. During parts of the experiment pecks at the changeover key (changeovers) were followed by a time-out (TO) period.

As TO length was increased, (a) the rate of changeovers decreased linearly as a function of the logarithm of TO length; (b) the proportion of responses emitted in the presence of the VI 1-min schedule increased; (c) there was an increase in the stimulus control of local response rates exerted by the different colors associated with each VI schedule. The results parallel previous findings from experiments using electric shock contingencies on changeovers, confirming the importance of the consequences of changeovers for concurrent performances. Quantitative relationships between the proportion of reinforced and the proportion of reinforcements in concurrent VI schedules can be viewed as being dependent upon the procedures used in reducing frequent alternations. (Aided by NASA grant NSG-450)

Section of Space Science and Technology

Forty-Seventh Annual Meeting of The Virginia Academy of Science
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MEASUREMENT OF ADSORPTION STAY-TIMES OF ARGON ATOMS ON A COOLED STAINLESS STEEL SURFACE. W.F. Bailey, Jr.[®] and S.S. Fisher, Dept. of Aerospace Engineering and Engineering Physics, Univ. of Virginia, Charlottesville, Virginia 22901

A preliminary experiment has been carried out using a simple time-of-flight method to determine mean times of adsorption of gas atoms on a solid surface. A room-temperature, aerodynamic-source, atomic beam of argon is pulsed by a slotted chopper disk, impinges on the "engineering surface" of a stainless steel target block, and a portion of the reemitted atoms passes through a density-sensitive, time-of-flight detector. The response (density versus time) of the detector to each pulse is compared for two cases: (i) target at room temperature and (ii) target at 80 to 100°K. The mean residence time of atoms on the surface in the target temperature range 80-100°K is inferred from the shift in the maximum of the detector response from case (i) to case (ii). Mean residence times up to 10^{-4} seconds are observed.
(Research sponsored by NASA Grant NGR 47-005-046.)

HEAT TRANSFER DISTRIBUTIONS FOR RADIATING SHOCK LAYERS INCLUDING ABSORPTION AND ENERGY DEPLETION. R.W. Barnwell, Dynamic Loads Div., NASA Langley Res. Ctr., Hampton, Va. 23365

Time-dependent finite-difference techniques are used to obtain numerical solutions for the problem of the inviscid flow of radiating equilibrium air past spheres traveling at hyperbolic velocities. The effects of absorption and energy depletion are included, and results are presented for both gray and nongray absorption coefficient models. It is shown that the nondimensional heat-flux distributions for the gray and nongray models are similar, and that these distributions are weak functions of the radius of the sphere and the altitude and strong functions of the flight velocity.

AN ANALYTICAL INVESTIGATION OF THE PRESSURE FIELD IN A CAVITATING FLOW. William Bober. Dept. of Engineering Mechanics, Virginia Polytechnic Institute, Blacksburg, Virginia 24061

Whereas most analytical investigators in the field of cavitation have studied the effects of a single cavitating bubble, this paper reports on the investigation of the pressure field resulting from the collective action of many bubbles. First, an expression for the pressure field on the walls of the constant-area test section of a two-dimensional venturi resulting from the growth and collapse of a single spherical bubble is derived. The potential field resulting from the action of many bubbles is taken as the sum of the effects of each individual bubble. The resulting formula for the pressure field requires the knowledge of the number of bubbles and the position, size and rate of growth of each bubble. Since, it is not practical to obtain this detailed information, a statistical approach is used. Assuming the knowledge of certain statistical information, a method is formulated for obtaining the expected pressure distribution on the wall in the constant-area test section.

MARS LANDING SITE ALTERATION BY ROCKET EXHAUST. Leonard V. Clark. Structural Dynamics Br., Dynamic Loads Div., NASA Langley Res. Ctr., Hampton, Va. 23365.

The prime mission objective for a Mars soft-landing vehicle will be scientific evaluation of the indigenous environment, including topology, geology, chemistry, and biology. Therefore, a knowledge of the nature and extent of any alteration to the surface and adjacent atmosphere as a result of the necessary rocket-braked descent is extremely important to the interpretation of the results from specific scientific experiments.

Studies are being conducted at NASA/Langley to assess the severity of the Mars landing site alteration problem. Using small, scaled cold gas jets operating in a large vacuum chamber at ambient pressures bracketing the expected Martian conditions, it has been established that erosion of particles on the Martian surface will begin while the lander spacecraft is at a considerable height above the surface. At lower heights corresponding approximately to that for thrust termination, impingement pressures and temperatures measured with larger-scale rocket motors for different thrust levels indicate the Martian ambient pressure condition is particularly bad from the standpoint of landing site alteration by spacecraft retrorockets. The studies are being extended to assist in selection of spacecraft-lander configurations and terminal maneuvers commensurate with some acceptable level of landing site alteration or contamination to onboard scientific experiments.

DEVELOPMENT OF AN ELECTROMAGNETIC POSITION SENSOR FOR THE "COLD BALANCE" WIND TUNNEL. R. E. Grandine
Dept. of Aerospace Engineering, Univ. of Va., Charlottesville, Va. 22903

The development of a magnetic balance system for a Mach 3 wind tunnel at the University of Virginia required the designing of a position sensor to complete the control loop of the balance and to obtain aerodynamic data. This report is an evaluation of an electromagnetic position sensor modified from a design by Mr. T. Stephens of K. I. T. for use in the Virginia's balance system. This sensor is capable of measurements of displacements along three orthogonal linear axes and the angles of pitch and yaw, and gives these measurements as a D-C output voltage.

The sensor was evaluated as to its linearity and stability of output, and its range of measurement. The results of this evaluation showed the sensor to be linear in the measurements of the rectilinear displacements over a range of ± 2.5 cm with an accuracy of 0.8 mm. The linearity of the angular measurements could not be determined because of stability problems with the angular output voltages. Both the rectilinear and angular outputs of the sensor tend to be unsteady and subject to drift, making the present sensor design unsatisfactory. (NASA Grant NGR-47-005-029)

THE EFFECTS OF NON-LINEAR AERODYNAMICS ON MISSILE RESONANCE PHENOMENA.[†] Ira D. Jacobson^{*} and Thomas G. Perkins[‡]. Dept. of Aerospace Engineering and Engineering Physics, University of Virginia, Charlottesville, Virginia 22903.

A study of the aerodynamic resonances of a symmetric missile has been investigated. In present missile designs resonance, in general, is considered when the ratio of vehicle roll rate, p , to aerodynamic natural frequency, ω_n , is unity. An analysis of the equations of motion indicate that resonances may occur at values of this ratio different than one. Under appropriate assumptions, the equations for the motion of a symmetric missile can be reduced to an equation of the form,

$$\ddot{\gamma} N_1 f + N_2 f \cdot \dot{\alpha}_x \cdot \dot{\gamma}^2 = F_{ext}(pt)$$

Where N_1 , N_2 , and N_3 , are functions of the aerodynamics of the missile, f is either the real or complex part of the total angle of attack, and F is a body fixed forcing function, such as a mass unbalance. This analysis establishes the relationship of the aerodynamic derivatives and forcing function that will yield resonances at values of the vehicle roll rate to aerodynamic natural frequency ratio that differ from unity; and determines the changes in the "normal" resonance behavior due to the non-linearity of the equations of motion. (NASA Grant NGR-47-005-029)

RADIATION EFFECTS ON THE DRIFT MOBILITY AND DIFFUSION CONSTANT IN SEMICONDUCTORS. W. L. Kelly IV. NASA, Langley Research Center, Langley Station, Hampton, Va. 23365

Radiation damage data have been taken on numerous semiconductor devices which do not agree with theoretical predictions. One of the possible reasons for this lack of agreement is that the diffusion constant may be a function of radiation flux. In an effort to explore this possibility, measurements were made of the drift mobility and diffusion constant on N-type Germanium samples. Samples were then irradiated with 22 MeV protons and measurements made at increasing values of integrated flux.

The observed data indicated a possible increase in the diffusion constant and a decrease in the drift mobility. Alterations to the theory suggested by these data enabled more accurate predictions of damage characteristics to Germanium base transistors. By expanding measurement capabilities of the diffusion constant, one might expect reasonable predictions for damage characteristics for some semiconductor devices.

DRAG COEFFICIENTS AT SATELLITE VELOCITIES. R. R. Humphries^{*} and J. W. Boring, Dept. of Aerospace Engineering and Engineering Physics, Univ. of Virginia, Charlottesville, Virginia 22903

Measurements have been made of the momentum transfer to solid surfaces by N_2 molecules in the energy range 8-200 eV (velocity range $7\text{--}37$ km/sec.). The results are obtained as a function of angle of incidence, thereby permitting one to calculate drag coefficients for solid bodies of arbitrary convex shape moving through a rarefied N_2 gas that has thermal motion that is negligible compared to the velocity of the body.

The measurements involve the production of a beam of neutral N_2 molecules of the appropriate velocity, allowing this beam to strike the surface of the test material at the desired angle of incidence, the measurement of the force exerted on the surface by the beam, and the determination of the particle flux in the beam. The test surface is mounted on a sensitive torsion balance which is also used to measure the beam flux through the use of "momentum trap".

Measurements have been made on surfaces that are samples of the satellites Echo I and Echo II, with the results showing that the average reflected momentum can be as large as 0.2 times the incident momentum. When the results are used to calculate drag coefficients for spherical bodies, it is found that values are obtained in the range $1.9 < C_D < 2.2$.

INVESTIGATION OF PHASE CHANGE EFFECT FOR DEVELOPMENT OF VARIABLE THERMAL CONTROL COATINGS. W. C. Kellher^{*} and P. R. Young[†]. NASA-Langley Research Center, Langley Station, Hampton, Virginia 23365

Temperature control in present space vehicle systems is generally achieved through the use of passive and/or active thermal control systems. The passive coating systems, while being light weight, reliable and simple in operation, cannot compensate for any environmentally or internally induced changes in the thermal behavior of the vehicle. Active control systems while being able to compensate for these types of thermal changes, are heavy, cumbersome, and subject to mechanical failure of moving parts. To overcome these limitations, a surface coating has been developed that will automatically regulate the heat flow of a spacecraft to compensate for internally and externally-induced changes in the thermal balance of the vehicle. This new coating system utilizes the change that occurs in the optical properties of many materials during the phase transition from a crystalline solid to an amorphous material and is therefore called a phase change coating.

Model coatings, utilizing this effect, exhibited a 50% decrease in their absorptance to emittance ratios when backed by a specularly reflecting surface. Microscopic examinations of the coatings have revealed that the effect is due to a combined temperature dependent solubility and phase equilibria involving the inclusion material and the polymeric binder.

PREDICTION OF AIRCRAFT AND SPACE VEHICLE HANDLING QUALITIES. F. H. Lutze, Jr., R. F. Giles^{*}, Dept. of Aerospace Engrg., Va. Polytechnic Inst., Blacksburg, Va. 24061.

The closed loop pilot-vehicle system has certain characteristics which a pilot considers "good" or "bad". Such classifications have been obtained from previous simulator or flight tests. The classical control approach which includes the mathematical definitions of the root-locus diagram, system phase margin, and crossover frequency allows expressions to be written which relate pilot-vehicle closed loop performance to the dynamic characteristics of the vehicle only. The previously determined bounds on the closed-loop performance allow closed-form equations to be developed which predict the boundaries on the vehicle dynamic characteristics for "good" control of the vehicle.

A PERTURBATION TECHNIQUE FOR SOLVING BOUNDARY-VALUE PROBLEMS ARISING IN THE ELECTRODYNAMICS OF CONDUCTING BODIES. James E. Mann, Jr., Department of Applied Mathematics & Computer Science, Univ. of Va., Charlottesville, Va. 22901.

In treating the electrodynamics of shielding, certain problems in geophysics, and other problems involving conducting materials, we are presented with boundary value problems of great difficulty. To mitigate some of the difficulties simpler boundary conditions have been introduced. The Leontovich boundary condition is one such condition. This condition is discussed and certain practical and philosophical difficulties with the condition are noted. Finally, another boundary condition is proposed which allows us to compute solutions to any degree of accuracy by a perturbation technique.

DATA ACQUISITION SYSTEM FOR THE THREE-DIMENSIONAL MAGNETIC SUSPENSION BALANCE FOR WIND TUNNELS WITH SPECIAL REFERENCE TO AEROELASTIC MODELS[†]. R. K. Manay, O. P. Mediratta, Dept. of Aerospace Engineering and Engineering Physics, Univ. of Va., Charlottesville, Va. 22903.

This paper reviews data acquisition systems from the standpoint of their suitability for investigation of aeroelastic behavior of models with the Three-Dimensional Magnetic Suspension Balance for Wind Tunnels. An electromagnetic system based upon the differential transformer principle enabling quantitative measurement of "motion within a motion" for an elastic model is discussed. This system will facilitate investigation of flexural and torsional behavior of models in both static and dynamic modes.

A loop tuned for a specific frequency, located on the model, has a resonant current induced in it by a suitably positioned excitation coil. This will in turn produce a smaller field which is superimposed on the excitation field as a perturbation. This small perturbation is the desired signal since it is a function of the loop's position and is detected by suitably positioned sensing coils. When several of these "tuned" loops are placed in various positions on an elastic wind tunnel model, information concerning the motion of different parts of the model with respect to a fixed reference frame can be selectively extracted.
†(NASA Grant NGR-47-005-029)

THE EFFECT OF ENTRANCE SHAPE ON TUBE FLOW IN THE TRANSITION REGIME. James F. Marchman, III, Virginia Polytechnic Institute, Blacksburg, Va. 24061

Comparison is made of a recent experimental study of transition regime flow through short tubes with square edged entrances with an earlier similar study using a bell-mouthed entrance. Both sets of data are compared with the free molecule tube flow theory of Clauzing in order to determine the effect of tube entrance shape on the applicability of the theory. It is shown that the use of a bell-mouthed entrance makes comparison of experiment with theory difficult. Ranges of validity for previously used means of determining "effective" length-to-diameter ratios for smooth entrance tubes are discussed. Conclusions are reached as to which types of entrance should be used for experimental work in the various flow regimes and further work is suggested to determine the mechanism of entrance flow separation.

GEOMETRICAL INFLUENCES ON FRACTURE TOUGHNESS PROPERTIES OF A HIGH STRENGTH STEEL. W. R. Thompson, R. P. McNitt, Engr. Mech., V.P.I., Blacksburg, Va. 24060

An experimental program was carried out to study geometrical effects on Stress Intensity Factors. The expression for critical stress intensity factors recently developed by Harris for hollow notched tensile specimens is utilized. The theoretical expression assumes that the notch root radius is zero.

The hydrogen embrittlement mechanism is utilized to initialize cracks in several specimens as the crack tip is essentially zero radius. The stress intensity factors for these specimens agree very well with other published values of the same material (AISI 4340). The effects of finite notch radii were investigated and found to significantly effect the solid and small axial hole specimens. However it was determined that for large axial holes (thin walled) specimens the experimentally determined notch radius did not appear to effect the stress intensity factor which were close to the value determined for the zero notch radius specimen. This suggests that thin walled notched specimens could be used in determining stress intensity factors.

THEORY OF RADIOACTIVE IONIZATION GAS DENSITY GAUGE FOR USE IN SPACE[‡]. W. K. Meshejian, W. P. Trower and D. S. Wollan, Physics Dept., Va. Polytechnic Inst., Blacksburg, Va. 24061

Ionization chambers and proportional counters can be adapted to determine the density of a gas in a cell by measuring the ionization currents between two electrodes. The ionization is produced by a radioactive alpha or beta source near the electrodes. Such a device can be used to monitor the puncturing of gas-filled cells by micrometeoroids in space, and thus to measure the micrometeroid flux. This device has the advantages of small size, light weight, quick response, absence of moving parts, and relative insensitivity to vibration. The theory of radioactive detectors relevant to this application is discussed.

A STUDY OF THE PHYSICAL ADSORPTION OF NITROGEN GAS ON POLISHED 347 STAINLESS STEEL AT VERY LOW PRESSURES. R. A. Outlaw*, NASA-Langley Res. Ctr., Hampton, Va. and J. P. Wightman, Dept. of Chemistry Va. Polytechnic Inst., Blacksburg, Va. 24061.

This investigation involves the study of the physisorption of nitrogen on a polished 347 stainless steel surface in the range 1×10^{-9} to 1×10^{-7} torr. Characterization studies on the polished 347 stainless steel surface were also conducted utilizing a scanning electron microscope to determine topology and an ion microprobe mass spectrometer to determine surface composition. The stainless steel surface was cleaned in vacuo by thermal bakeout to 400°C for 48 hours. Adsorption measurements were made by employing a dynamic technique. Adsorption isotherms were constructed for temperatures of 87.7°K and 77.4°K. The data were tested for fit to the Dubinin-Radushkevich equation. Isoteric heats of adsorption were calculated and plotted against relative coverage.

An adsorption isotherm was also constructed for nitrogen physisorbed on 7740 Pyrex glass at 77.4°K. This well studied experiment was repeated in order to evaluate the vacuum system and the dynamic technique used.

[†]This work supported by NASA contract NAS 1-8145.

OBSERVED INTERACTIONS OF THERMAL-ENERGY GAS ATOMS WITH VAPOR-DEPOSITED SILVER SURFACES. G. A. Pjura, Jr.,^{*} and S. S. Fisher. Dept. of Aerospace Engineering and Engineering Physics, Univ. of Virginia, Charlottesville, Virginia 22901.

Nearly monoenergetic atomic beams of helium and argon are scattered from the surface of silver which has been vapor-deposited in monocrystalline form on a heated mica substrate. The intensity and velocity distributions of the scattered atoms are mapped, using time-of-flight electronic detection methods, both within and without the plane of incidence as a function of target temperature and direction of the incident atomic beam. Target heating has a pronounced effect, with the scattering almost diffuse at 300°K and almost specular (for helium) at 600°K surface temperature. The most highly directed scattering is observed with helium at nearly tangential incidence. No strong dependence on azimuth of the incident beam is noted. (Research sponsored by NASA Grant NGR 47-005-046.)

OPERATIONAL CORRIDORS FOR EARTH ENTRY VELOCITIES OF 30 000 FPS TO THE LIMITING VELOCITY. E. Brian Pritchard, Aero-Physics Division, NASA Langley Research Center, Hampton, Va. 23665.

Theoretical entry corridors have been defined in the literature for a wide variety of entry vehicle capabilities and entry velocities. Little effort, however, has been devoted to operational corridor analyses which consider the following operational factors.

- (a) High Mach number, low Reynolds number effects.
- (b) Aerodynamic coefficient uncertainties.
- (c) Atmospheric density variations.
- (d) Delayed pilot and/or vehicle response.
- (e) Thermal protection capability.

This paper defines the effects of the above factors on the entry corridor for two classes of vehicles (lift-drag ratios of 1.2 and 3.5) entering the Earth's atmosphere at speeds of 30 000 fps to the limiting entry velocity (zero corridor). The corridor degradation due to each operational factor in turn is presented to demonstrate the magnitude of its effect. It is shown that the high Mach number, low Reynolds number effects and the aerodynamic coefficient uncertainty effects are generally small throughout the range entry velocities. Larger reductions in corridor are obtained when the expected atmospheric density variations are considered.

Operational corridors must be considered if realistic conclusions are to be drawn concerning the performance required of any entry vehicle.

EVALUATION OF STABILITY DERIVATIVES FROM U VA. WIND TUNNEL BALANCE SYSTEM.[†] B. S. Raghunath*. Dept. of Aerospace Engineering and Engineering Physics, University of Virginia, Charlottesville, Virginia 22903.

The paper discusses the feasibility of evaluating C_{m_x} and C_{m_y} , separately from the "free motion" of a model in a wind tunnel with an electromagnetic support system. The type of motion which will be of interest to do this is related to the characteristics of the facility. *(NASA Grant NGR-47-005-029)

OPERATIONAL RADIOACTIVE IONIZATION GAS DENSITY GAUGE FOR USE IN SPACE[‡]. K. Ramamurti, W. P. Trover and D. S. Wollan. Physics Dept., Va. Polytechnic Inst., Blacksburg, Va. 24061

A parallel plate ionization chamber using a 250 micro-curie Americium-241 foil source has been built for satellite borne micrometeoroid detection. Saturation currents measured at 175 volts range typically from 5×10^{-8} amp at 760 torr to 2×10^{-6} amp at 1 torr, the variation being roughly linear. Several gases and mixtures of gases are found to give currents of the same order of magnitude. The response time of the gauge to pressure changes is within the response time of the pressure and current measuring instruments and has not been measured accurately. The cylindrical geometry in general gives lower currents than the parallel plate geometry at voltages less than 300 volts. In the proportional counter region currents as high as 10^{-5} amp have been obtained, but the current is not a monotonic function of the pressure. Construction and characteristics of a gauge based on these results is discussed.

[†]This work supported by NASA contract NAS1-8145.

IMPROVEMENTS OF THE DONNELL EQUATIONS FOR CYLINDRICAL SHELLS. J.G. Simmonds* and D.A. Danielson* (sponsored by J.E. Mann, Jr.), Dept. of Applied Mathematics & Computer Science, Univ. of Va., Charlottesville, Va. 22901.

Circular cylindrical shells find wide applications because of their simple geometry, yet their mathematical analysis remains a formidable task, even if attention is restricted to simple types of loads. In 1933, Donnell showed that if the circumferential "wave length" of the deformation pattern, L_0 , were small compared to the cylinder radius R , then the governing equations could be reduced to a simple 8th order equation for the radial displacement. The Donnell equations have probably formed the basis of over 500 papers on the linear and nonlinear behavior of cylindrical shells. These equations, however, contain several serious shortcomings, all resulting from the assumption that $(L_0/R) \ll 1$. For example, rigid body motions do not produce zero strains. In a series of recent papers, the writers have developed equations for cylindrical shells that embody the simplicity of the Donnell equations, but retained the accuracy of the full, unreduced shell equations. Highlights of this work are reviewed and several problems now under investigation are discussed.

DYNAMIC STABILITY OF STRUCTURAL AND AEROELASTIC SYSTEMS VIA THE DIRECT METHOD OF LIAPUNOV. Warren D. Smith, Dept. of Aerospace Engineering, Va. Poly. Inst., Blacksburg, Va. 24061.

The application of Liapunov's direct method to dynamic stability of structural systems is discussed. The classes of structural systems considered include nonlinear systems, autonomous and non-autonomous systems, initial value problems, nonconservative systems (including aeroelastic systems), continuous systems and discrete systems. The dynamic snap-through of a shallow cylindrical shell is examined as a particular example for several of these classes of structural systems.

FUNDAMENTAL PARAMETERS OF THE ANISOTROPIC VELOCITY DISTRIBUTION FUNCTION. Yau Wu, Department of Aerospace Engineering, Virginia Poly. Inst., Blacksburg, Va. 24061

Certain special mean molecular speeds and relations of these mean speeds can be calculated from the anisotropic distribution function in the same manner as those calculated from the Maxwellian distribution function. The anisotropic velocity distribution function has been shown to be an exact solution of the Boltzmann equation for a Knudsen gas contained in a closed system with an arbitrary temperature distribution on the boundary. A measure of the derivation of velocity distribution function from Maxwellian is introduced as "Isotropy" for a stationary state. This factor occurs repeatedly in the fundamental parameters and relations between mean molecular speeds and has been applied in the problems of the thermal molecular flow such as thermal transpiration, thermal conduction, molecular radiometric force and others.

Section of Statistics

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THE PROBABILITY OF MISCLASSIFICATION OF GRADES IN MULTIPLE CHOICE EXAMINATIONS. M.H.Carter, Jr., Dept. of Biometry, Med. Coll. of Va., Health Sci. Div., V.C.U., Richmond, Va. 23219

On multiple choice examinations a correct answer to a question can be given (1) through knowledge of the answer or (2) by guessing. Since some students are better guessers than others, it is possible that in comparing two students the student who gave fewer correct answers actually knew the answer to more questions than the student who gave more correct answers and obtained a higher grade. No mention is ever made of the probability of the occurrence of such an event, i.e., the probability of misclassification, PMC. In this paper a method is developed for estimating the PMC. In order to do so it is necessary to assume the existence of a set of questions, Λ , which will accurately measure a student's ability to answer questions for which he does not know the correct answer. It is further assumed that, for each student, the probability p_0 of guessing the correct answer to a question follows a Beta distribution with parameters a and b which must be estimated. This differs from the usual assumption that $p_0 = 1/r$, where r is the number of possible answers to a question. A method is indicated for estimating a and b for each student from his performance on questions taken from Λ and included on the examination. It is further shown that it is possible to obtain the PMC for students who answered the same number of questions correctly, if the estimated values of the parameters of the Beta distribution are different for each student. Hence, students who obtain identical raw scores on such an examination can be ranked through use of the PMC.

CHARACTERISTIC FUNCTIONS OF FUNCTIONS. I. J. Good, Dept. of Statistics, Va. Polytechnic Inst., Blacksburg, Va. 24061

A formal process is given for expressing the characteristic function ($C.F.$) of a function $g(X)$ in terms of the characteristic function ϕ of X , together with some examples and deductions. A further formalism relates the Mellin transforms of the C.F. and probability density (P.D.) of X . When applied to multivariate stable distributions the formalism leads to generalizations of parts of multivariate statistical analysis. For example (i) formally

$$C.F.(X^2) = \frac{1}{\sqrt{2\pi}} \int_{-\infty}^{\infty} e^{-v^2/2} \phi(e^{-x^2/4} \sqrt{2t}) dv; \quad (ii) \text{ If } X \text{ and } Y \text{ are independent and both have the stable distribution with C.F. } \exp(-\alpha|t|^{3/2}), \text{ corresponding to the distribution of acceleration in a chaotic three-dimensional environment, under an inverse square law, then an explicit formula is given for P.D. } (XY); \quad (iii) \text{ If the vector } x \text{ has the real stable C.F. } \exp(-\lambda(t^2 C)^{1/2}), \text{ where } C \text{ is non-negative definite, then } x' C^{-1} x \text{ has a distribution } X_{n,\lambda}^*(m) \text{ mathematically independent of } C. \text{ If } Y \text{ has an } m\text{-dimensional Wishart distribution with } v \text{ degrees of freedom then } T_{n,\lambda} \text{ defined as } x' Y^{-1} x \text{ has the distribution of } X_{n,\lambda}(m)/\chi^2(v-m+1) \text{ where the numerator and denominator are statistically independent. } T_{n,\lambda} \text{ is a generalization of Hotelling's } T^2. \text{ A formula is obtained for C.F. } (\log T_{n,\lambda}) \text{ and for C.F. } (T_{n,\lambda}^2).$$

SOME POTENTIAL USES OF PHOTOGRAPHS IN ESTIMATING PRODUCTION OF TREE CROPS. Earl E. Houseman*, Director, Standards and Research Div., Stat. Rept. Service, U.S. Dept. of Agr., Washington, D. C. 20250

In recent years the Statistical Reporting Service in the USDA has placed new emphasis on the development of methods of forecasting and estimating the production of tree crops from objective measurements during the growing season. This paper discusses research in progress on methods of estimating apples and peaches. The methodology under study makes use of photographs for two purposes. In the spring, before foliation, photographs of sample trees are taken and used in the office as sampling frames for selecting and designating a sample of limbs for direct counting of fruit. This relieves field crews of the task of selecting sample limbs and avoids potential bias in their procedures even though they are given precise instructions. Secondly, after fruit have been formed, fruit counts from photographs are made. The photo counts must be correlated with direct physical counts in order to get a basis for estimating total fruit numbers from photo counts. However, the making of accurate direct fruit counts on sample limbs is difficult to achieve especially in a large scale survey. Photo counts in combination with direct counts can reduce the amount of direct counting that may be necessary.

STOCHASTIC MODEL FOR BOD AND DO IN ESTUARIES.

Richard G. Krutchkoff, and Stephen W. Custer. Dept. of Statistics, Va. Polytechnic Inst., Blacksburg, Va. 24061

A stochastic model describing the oxygen consuming pollution and the dissolved oxygen in an estuary is developed. The model yields analytic and numerical forms for the probability distributions of the dissolved oxygen and the Biochemical Oxygen Demand, as a function of the estuary parameters.

A unit of pollution is assumed to follow the pattern described by a random walk on the real axis. The probabilities which govern the direction of the motion are functions of the longitudinal velocity. In addition, each unit of pollution has a probability of decaying in any time interval.

When a unit of pollution decays due to the bacterial action, an equal amount of oxygen is consumed. The oxygen decay forms oxygen deficiency, which may be treated as a new diffusing unit. The unit of oxygen deficit is subject to the random walk phenomenon.

The stochastic model is verified by comparison with data from the Potomac Estuary near Washington, D. C. (Supported by FWPCA Grant WP-01216.)

ANALYSIS OF MULTI-DIMENSIONAL CONTINGENCY TABLES. H. H. Ku, National Bureau of Standards. Washington, D. C. 20234

Under a null hypothesis of interest, the cell probabilities of a contingency table are either completely specified, or are estimated from observed or given marginal frequencies. A method of estimation based on minimizing the discrimination information,

$$I(p;\tau) = \sum p_i n_i \frac{p_i}{\tau_i}$$

has been proposed where p and τ with appropriate indices are the observed (hypothesized) and the hypothesized (observed) cell probabilities respectively.

It has been shown that these estimates, p^* , (A) are RBAN, (B) can be computed by a convergent iterative scheme and (C) can be expressed in a logarithmic linear additive form of parameters. In addition, (D) $2nI(p;\tau)$ is asymptotically distributed as χ^2 .

Application of this estimation procedure and the resulting test statistic includes classical tests of independence, tests of second - and higher - order interactions, and estimation of parameters. Examples will be discussed.

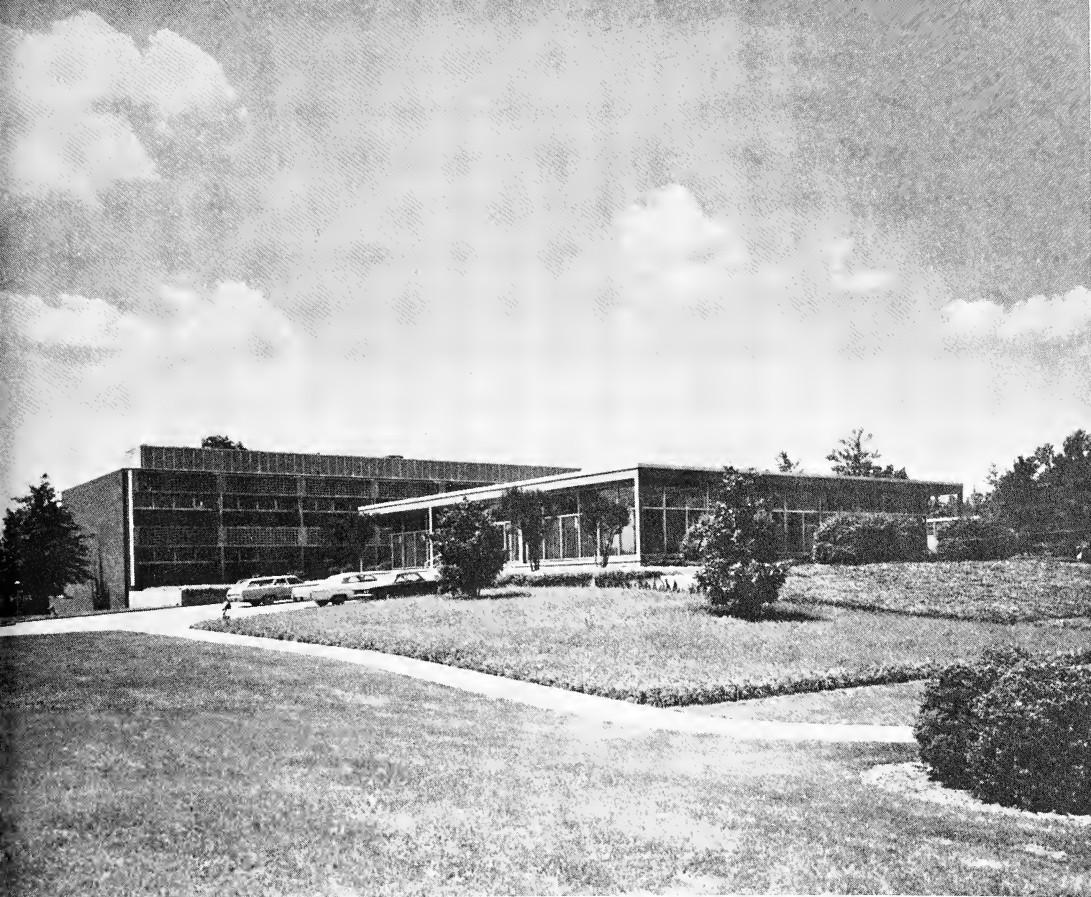
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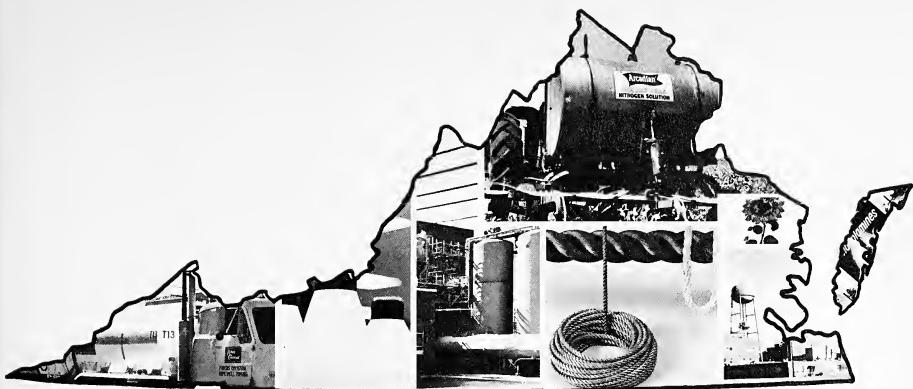
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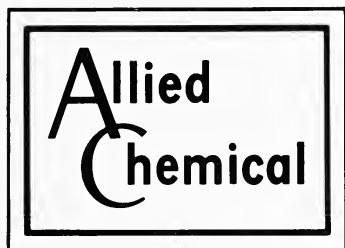
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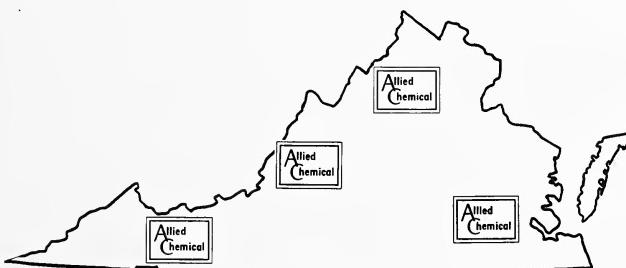
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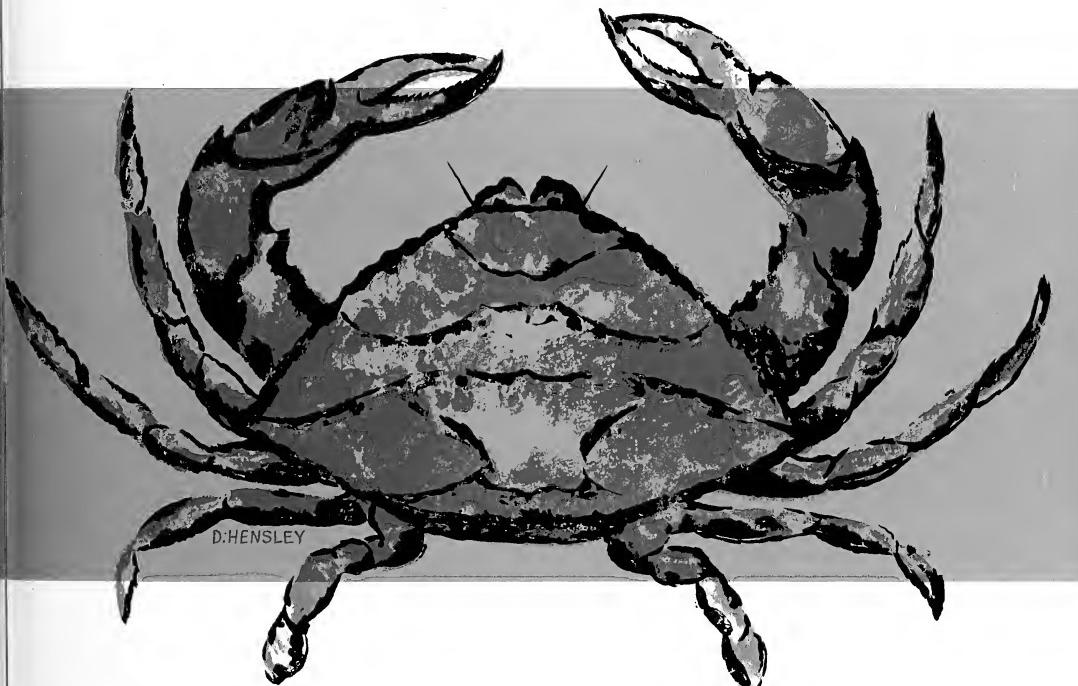
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Pinpointing a future in Virginia

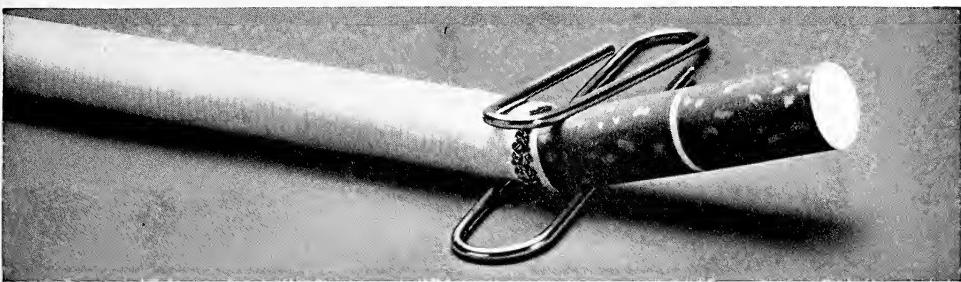
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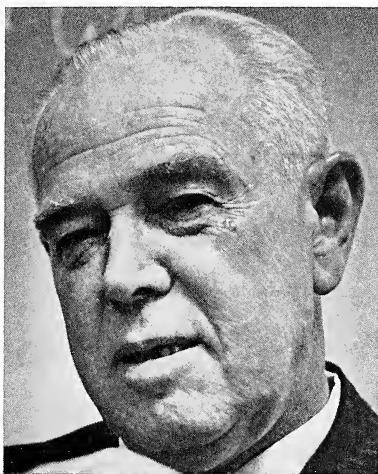
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William George Guy 1899-1969

William George Guy, thirty-fifth president of the Virginia Academy of Science and Chancellor Professor of Chemistry Emeritus at the College of William and Mary, died in Jacksonville Beach, Florida, June 14, 1969.

Professor Guy was born at Carbonear, Newfoundland, March 17, 1899. As the 1916 (Queen Victoria) Jubilee Scholar for that country, he entered Mount Allison University at Sackville, New Brunswick, and was awarded two degrees (B.Sc. 1919; B.A. 1920). In 1920 he was selected as the Newfoundland Rhodes Scholar and spent the years 1920-23 at Oxford University and won its coveted A.B. degree. He was a duPont Fellow at the University of Chicago where he was elected to Sigma Xi and in June, 1925 was awarded the Ph.D. degree.

In September, 1925 he joined the faculty of the College of William and Mary as Assistant Professor of chemistry, was promoted to Professor within five years, and appointed one of the original Chancellor Professors in 1945. He served as Head of the Department of Chemistry from 1946 until his retirement in 1968.

Early in his career at William and Mary, he was recognized and honored by students and colleagues by election to Omicron Delta Kappa and Phi Beta Kappa. In later years the College of William and Mary conferred upon him the Thomas Jefferson Faculty Award (1964) as one "adjudged the William and Mary faculty member whose personal and professional accomplishments most reflect the Jeffersonian educational ideals," and the Algernon Sydney Sullivan Award "for character and service . . . to the college." At the College's Charter Day Convocation in February 1969, he was awarded the honorary Doctor of Science degree.

Professor Guy's influence and contributions extended far beyond the classroom where he taught general chemistry for forty-three sessions and physical chemistry for almost as long. His professional involvement resulted in election as chairman of the Virginia Section-American Chemical Society for 1951-52 and the conferral of its Distinguished Service Award in 1958. He was President of the Virginia Academy of Science, 1957-58. His service to the community was characterized by membership on the Board of Zoning Appeals and the Board of Trustees of the Williamsburg Community Hospital.

Apart from tennis where he continued to wield a strong racket until well past middle life, Bill Guy took his athletics vicariously. The games that he grew up on were soccer, ice hockey and cricket.

Bill and Gladys Elizabeth Bennett of Williamsburg were married in 1926. Their home on 'Governor's Hill' became as distinctive in its way as many of the restored homes downtown. Hospitality was dispensed with graciousness to chemists, college friends and visiting dignitaries.

We of the Virginia Academy of Science, indeed, the entire scientific and intellectual community of the Old Dominion are the richer for his having lived among us. He will be missed by his many friends, students and colleagues.

Joseph James Murray†

*6 Jordan Street
Lexington, Virginia 24450
Received August 5, 1968*

The Birds of the Dismal Swamp*

On a May night four men were camped at the edge of Lake Drummond in the heart of the Dismal Swamp. We had gone there to make a survey of the nesting birds of the region. In the afternoon we had paddled up the Washington Ditch. We had unpacked, arranged our gear about the little cabin, and had our supper. Now it was dark. The chimney swifts which at twilight we had seen wheeling above the cypresses and dipping down to drink on the wing had gone to roost in their ancient manner in the hollow trees out in the lake. All about us the little frogs were singing their love songs. From the black woods a pair of barred owls screamed in loud and startling courtship. In the breeze the little waves lapped quietly against the piling beneath the house. And so we slept.

At sunup the trees were active with small birds beginning the duties of the day. A few, at the end of May, were still in migration. Blackpoll warblers and gray-cheeked thrushes were making their way up through this southern wilderness toward their own far north country. Most of the birds about us had settled down to the serious business of mating and nest-building. Some were already struggling to fill the hungry mouths of small young. When we opened the door that looked out on the lake a mother wood duck hurried her brood into the shelter of the woods. Great pileated woodpeckers, striking in black and white and red, were shuttling back and forth between the giant gum trees in the swamp, where their nesting holes already had eggs, and the rotting cypress stumps in the lake, where their favorite grubs abound. Sometimes from the stumps and sometimes on the wing they shouted forth their call, "whucker, whucker, whucker." And always the air overhead was noisy with the high-pitched chittering of the chimney swifts.

In the days of the week that followed we explored all the central part of the Swamp: the lake itself; the Jericho Ditch, through the juniper brakes and out into the "lights," as the cut-over areas of the Dismal are named locally; the Portsmouth Ditch, full of water plants in bloom; and as much of the swampy area as was dry enough for travel on foot. This was not our first nor our last trip to this entrancing spot, for to any nature lover who has once seen the Dismal there is a constant call to come again and again.

* Editor's note: This is the first of a series of articles on the Dismal Swamp which will appear in the Virginia Journal of Science.

† Former Editor of *The Raven*, The Virginia Society of Ornithology Bulletin.

There are few really wild spots left in the eastern United States. Here in the Dismal Swamp, only a few miles from the busy industrial area of Hampton Roads, there is country such as the Indians knew in pre-Columbian days. Here no man lives. Here, at least until recent years, nature could still have her way. Here it is still possible for a pileated wood-pecker, or a Virginia deer, or a black bear, or a cottonmouth moccasin to go through its whole reproductive season and never see a deadly human being. Here, in spite of what logging crews and drainage squads and forest fires have already done, and in spite of our fears of what the coming years may bring, there is still the wilderness; and here, birds both small and great abound.

Probably the earliest and certainly the most jaundiced account of the life of the Dismal Swamp was given by Colonel William Byrd of Westover in his *History of the Dividing Line betwixt Virginia and North Carolina*. One of the best editions of this book was done by William Boyd and published by the North Carolina Historical Commission in 1929. Colonel Byrd was one of the Virginia members of the joint commission which was appointed to survey the line between the two states and settle the boundary dispute that had gone on for years. Byrd had heard a great deal of the terrors of the Swamp and was filled with horror at the thought of trying to traverse it. It is not difficult to conclude that he did not see the Swamp but is writing about it at second-hand.

In an often quoted passage he says about it: "Since the Surveyors had enter'd the Dismal they had laid Eyes on no living Creature: neither Bird nor Beast, Insect nor Reptile came in View. Doubtless, the Eternal Shade that broods over this mighty Bog, and hinders the sun-beams from blessing the Ground, makes it an uncomfortable Habitation for any thing that has life. Not so much as a Zealand Frog cou'd endure so Aguish a Situation. It had one Beauty, however, that delighted the Eye, tho' at the Expense of all the other Senses: the Moisture of the Soil preserves a continual Verdure, and makes every Plant an Evergreen, but at the same time the foul Damps ascend without ceasing, corrupt the Air, and render it unfit for Respiration. Not even a Turkey-Buzzard will venture to fly over it, no more than the Italian Vultures will over the filthy Lake Avernum, or the Birds in the Holy-Land over the Salt Sea, where Sodom and Gomorrah formerly stood." In another place he does say that "they espied a Turkey-

Buzzard, that flew prodigiously high to get above the Noisome Exhalations that ascend from that filthy place." Plainly, the gentleman did not like the Dismal Swamp; plainly also he never actually entered it.

It is more disconcerting to find in one of the most fascinating of recent nature books the suggestion that the bird life of the Dismal Swamp is not so rich as has been pictured. Edwin Way Teale, in *North with the Spring*, writing of a trip along the Feeder Ditch into the Swamp, speaks of his disappointment at finding it, even in the high tide of May, rather sparsely inhabited by birds. One hesitates to differ with so experienced a naturalist, but it is unavoidable, for the honor of our Swamp is at stake. Surely he did not have a normal day in the Swamp! Possibly it was a windy day, which always brings disappointment in a bird count. Clearly, too, he went into the Swamp too late in the day and with too noisy an equipage. In contrast, one year later on a May morning three of us followed the same route into the Swamp. We, however, entered the Feeder Ditch just as the sun rose and paddled up the canal quietly, some of us walking the bank at times. Where our writer mentioned that they once caught a glimpse of a prothonotary warbler, we listed twenty between Crockett's landing and the lake. In this trip we saw 41 species of birds and counted 284 individuals. In midsummer, when birds are quiet, the counts would be smaller. Two of us took this same trip along the Feeder Ditch in July, finding only 31 species and only 181 individual birds. In winter, when certain species are flocking, the numbers would be much larger.

Since the territory of the Dismal Swamp is limited to a few specialized habitats, the number of species of birds to be found may not be as great as in a more diversified territory of the same size in the coastal plain of Virginia, but the species that occur are represented by individuals in abundance. Some counts may be of interest. Paul Bartsch on two June trips, in 1897 and 1899, saw 53 species. The writer, with three companions, listed 61 species in four days in May 1932. Charles E. Stevens, Jr., and William F. Minor in one day in May 1946 counted 28 species near the Lake and 23 additional species in the "lights." Some 65 species of breeding birds have been recorded for the Dismal Swamp. A few other birds have been recorded in summer for which we have no breeding evidence. Probably at least 75 species will be recorded as breeders. As practically all the trips taken into the Swamp for birds have been in late May and early June, there are an indefinite number of migrants and winter visitors that could be added to the list for the area. Apart from the breeding season our records are of little value.

The Jericho Ditch

It may give a clearer picture of the Swamp and its bird life if the trips of May already referred to are described in more detail. On the afternoon of 12 May we entered the Suffolk end of the Jericho Ditch. The dark swamp water, colored like strong tea, coming out of the distant juniper brakes, poured

over a simple dam of logs and boards. One of the odd things about the Dismal Swamp is that the flow of water is out from Lake Drummond, for the water level in the lake is higher than that of the surrounding swamp. Up the northern side of the canal a path winds along the bank. On the opposite side a wide roadway, which spells destruction to that corner of the Dismal, was being built into the heart of the swamp for lumber trucks. Its ugliness may in some measure heal over in time, but never again will the Jericho Ditch wind a secluded and sheltered way through the juniper tangles. Man's machinery has opened the way for industry but wrecked the wild beauty of the swamp.

It was a cool, clear day but too windy as well as too late for good bird observation. We crossed an open glade where power wires stretched overhead and where the watery soil was covered with pale blue wild iris. In the edges of the glade grew great banks of cinnamon ferns. Soon we entered the forest of tall trees, among them sweet magnolia bays in bloom, filling the air with a delicate fragrance. In the piled up soil across the canal we could see many shells: pectens, from an inch to six inches across, some of them still joined in pairs; clam shells, some of them fluted and as large as a man's hand; and small white, roughened shells, like the shells so abundant in canal banks in the Florida everglades. Farther along, where the roadway had been cleared through the juniper growth and the branches had been piled up, the air was aromatic from the dry foliage. We could not escape a feeling of sadness as we remembered former years when it was dark under the over-arching branches and when the roots gave a sweet taste to the cool water.

Since it was early afternoon, we did not expect many birds. Sometimes we went through belts of silence, where not even a hooded warbler whistled. Then would come bursts of sound, with birds on every side, crested flycatchers and red-eyed vireos and Carolina wrens, wood thrushes and prothonotary warblers, with an occasional northern thrush, such as a veery or an olive-back. In an old woodpecker hole in a stub by the path we found the nest of a Carolina chickadee with its five tiny spotted eggs. An occasional turkey vulture or black vulture sailed overhead, but not a hawk was to be seen that day. In front of us a great blue heron moved by stately stages up the ditch, and twice a green heron went squawking by. Woodpeckers were active, mostly downies and red-bellies, although twice in the distance we heard the loud challenge of a pileated.

The traveler in the Dismal is impressed by a sense of the immensity of its spaces. Everything else in the eastern Virginia world seemed small to us when we came out of the swamp that afternoon.

The Feeder Ditch

The simplest way to enter the Dismal Swamp is by boat up the Feeder Ditch. This canal, by which water is drawn from Lake Drummond for keeping up the level in the larger George Washington Canal, makes a straight line, slightly north of west, for three miles to the Lake Drummond dam at the

United States Engineer Corps Reservation, half a mile from the lake. A foot-path runs along the northern bank. Shortly after daybreak on 13 May we set out from Crockett's landing in a balky rowboat. The dark mist-covered water of the George Washington Ditch made a lane of beauty. There was such a volume of song from the trees on each side that it took one person's time to tally the birds. As we struggled into the Feeder Ditch with Captain Crockett's ancient craft, there was grim humor in the sign that faced us: "6 miles speed limit." We thought we were doing magnificently to make a mile an hour. Those who were elected from time to time to walk the path soon left the little vessel and its panting crew far behind. How long three miles of watery lane can seem when one can see each end but when half an hour of hard rowing seems to make no appreciable difference in the distance in either direction!

From the bank where the sweet bay trees grew we looked out for miles across the "lights," a world of high grass and ferns, of briars and bushes, with scattered clumps of deciduous trees and in the distance islets of juniper. These cut-over areas are growing up but, with the drainage that has taken place, will never again be like the original swamp.

The Reservation

The only civilized spot in the Dismal Swamp is the government reservation, known in the old days as the Waste Weir but now called the Lake Drummond Reservation and Spillway. Here the run of water from Lake Drummond into the George Washington Canal by way of the Feeder Ditch is controlled. Here families live and children play. Here, in contrast with the dark forest, are trim buildings and a green lawn. Here the more familiar dooryard birds are found, hummingbirds feed among the flowers, and the staccato trill of chipping sparrows can be heard. But here too, since the wilderness is just at hand, spotted sandpipers run about the yard in spring, as tame as chickens, and brilliant prothonotary warblers feed on the lawn about the picnic shelter.

Between the reservation and the lake swarms of birds were found, prothonotaries and redstarts and parula warblers, catbirds and migrating blackpoll warblers. In the dark water swam a small but deadly cottonmouth moccasin. At the mouth of the Feeder Ditch the high winds were driving a choppy sea and smashing the waves back among the trees of the swamp.

The Trail Through the Swamp

One of the best places to observe the characteristic birds as well as the plant growth of the Dismal is the winding trail that leads from the reservation to the fishermen's cabins, two miles away, at the mouth of the Portsmouth Ditch. This is one of the higher parts of the swamp. When we walked the trail that May afternoon it was high tide in the avian world. Some migrants were still passing through, but many of the summer residents already had young on the wing. It seemed strange in this

coastal swamp, so southern in all its atmosphere, to hear three varieties of northern thrushes, usually associated with the spruce woods of the high West Virginia plateau or with the New England mountains, but now singing along with our nesting wood thrushes. Once we heard the wild, ethereal melody of a veery. We identified at least one gray-cheeked thrush. The most common was the olive-backed thrush. The songs of these three resemble each other rather closely, except that the veery's spirals turn downward, while the olive-back's song wheels upward, and gray-cheek's has an upward turn at the end. All have the indescribable grace and mystery of the wilderness.

In the deep woods along this path we found the two species for which ornithological visitors to the Dismal are always on the alert: the Swainson's warbler, one of the rare southern warblers; and Wayne's warbler, here near the northern tip of its range. One is lucky to find the Swainson's once in three trips. Twice we heard and once some of the party saw this bird. There were Wayne's warblers on all sides. We counted ten singing males that afternoon, and found two family parties of male and female and tiny young on the wing. On former trips they had been associated with great pines in this area. The pines are now gone, but the warblers persist in other trees. Since there are so few specimens of this warbler available in museums for study, we collected two males and a fledgling for the United States National Museum.

Everywhere through the swamp we had the sense of life springing out of death. From the decaying vegetation of former generations new rank swamp growth was rising. Ferns abounded, some of them waist high and heavy, others smaller and more delicate. Wild grapes hung in long cords from all the trees, looping across the bushes. That year there was a heavy holly bloom, the tiny blossoms showering down to whiten the ground and the rotting logs. Overhead rose huge gums and maples, the high swelling arches of the roots well above the dry ground. Near the Portsmouth Ditch occasional openings, forty yards or so across, stood thick in canes and in blackberry vines higher than our heads.

The two most generally distributed birds of the swamp seem to be the red-eyed vireo and the hooded warbler. We were rarely out of sound of one or the other or both. Prothonotary warblers, too, are always heard except in the dry "lights." Few white-eyed vireos, strange to say, were around that day. Wood thrushes were common. Parula warblers were fairly common in the woods, although much more abundant around the lake. Woodpeckers, hairy and downy and red-bellied and pileated, are always to be heard at their carpentry in the big woods. As we came to the mouth of the Portsmouth Ditch spotted sandpipers were teetering on the stumps and the fallen logs.

Lake Drummond

At the heart of the Dismal Swamp lies Lake Drummond, slightly oval, three miles long and almost as wide. Thomas Moore, the Irish poet, is not

the only visitor whom it has fascinated. After a sight of the lake a hundred and fifty years ago, he sat in his hotel room in Norfolk and wrote his poem, "A Ballad—The Lake of the Dismal Swamp," which many of us learned in childhood. In it he tried, not too successfully, to picture the unearthly atmosphere at twilight of this mysterious, lonely piece of water.

Lake Drummond is lovely at all seasons: in summer when the hot sun, shining through a blue sky, makes its waves sparkle; in winter when the trees are bare and the same waves turn steel-gray; and above all in April when the maples make a circle of pale flame about its shores. And always there are birds. In winter flocks of ducks hurtle across its waters. In summer chimney swifts dart and chatter above it, although unfortunately not in such numbers as before the hollow trees were cut. Ospreys come from the coast to fish in its dark waters. High overhead the vultures wheel in lazy circles. And in the trees that rim it without a break the flycatchers and the warblers seek their insect prey.

High Summer in the Swamp

A trip into the Dismal Swamp in midsummer presents more difficulties and provides fewer rewards than does one in May. With Dr. John H. Grey I repeated the trip up the Feeder Ditch two months later on a dry July 17th, with the temperature well up in the nineties. We came out at noon with our clothes dripping and sweat running down our faces. Birds, of course, were much quieter, but the mosquitoes and deer flies were much more active. At intervals we had to stop to pick off the ticks that covered our shirts. Vegetation had grown tremendously during the weeks since May. What had been a fairly open path along the bank of the canal was now a rank growth, shoulder high with fennel and wild plums and a thorny bush locally and very appropriately known as "devil's walking stick." It was now difficult to see through the shrubbery at the edge of the bordering swamp. I am glad to have done this once at such a time, but never again!

Some species of birds had stopped singing altogether. Others were much subdued. A few, such as catbirds, Carolina wrens, Acadian flycatchers, yellowthroats, towhees, chickadees, bobwhites, and cardinals were in as good form as at the earlier season. Young birds on the wing added to the July counts. However, while undoubtedly present, most vireos and warblers were hidden away, sitting out the molt as best they could. We heard only a few red-eyed vireos, not a single prothonotary warbler where we had heard 20 in May, only one prairie warbler where there had been 28, one redstart where there had been 9, and three hooded warblers where May had produced 15. Some of the warblers, such as the hooded, were more active in the deep woods between the reservation and the Portsmouth Ditch, but even there not a Wayne's warbler out of all the May abundance was singing.

One interesting find was that of at least two pairs of cedar waxwings along the south side of the ditch. This date would seem to indicate that these birds, which nest very late, were going to nest in the area.

We have only one nesting record and very few summer dates for this species so near the coast. A robin, apparently the first recorded in the Dismal in summer, was seen near the eastern end of the Feeder Ditch. It may have been a wanderer from nearby open country. At two places a female wood duck appeared. We were hoping to find at the reservation the spotted sandpipers of May, but they did not show up. As always, a striking thing about the Dismal Swamp area was the practical absence of sparrows of any kind.

Ecological Units in the Dismal Swamp

Ecology is the study of animal and plant communities and their relationships to each other and to their total environment. It is based on the realization of the fact that the life of any individual animal is affected by all the other species of animals and plants with which it lives, and by all the natural factors of its environment, temperature, humidity, soil and many other things, and that, therefore, the whole complex, animate and inanimate, must be considered together. Ignoring the swamp borders and the intrusions of pieces of cultivated territory, there are two chief ecological communities in the Dismal Swamp, depending on the two principal areas of plant life. The most important of these, because the most typical and most extensive, is the Dark Swamp community, covered with heavy deciduous forest, in which black gum predominates. The other is the Light Swamp community, originally covered with an evergreen forest of white cedar ("juniper") but now almost barren of trees and covered with shrubs, briars, canes, and ferns.

There are many other smaller communities, such as Lake Drummond itself, the small reservation area, the canal banks, the swamp borders, and the cultivated or partially cultivated intrusions near the edges of the swamp. In each of these habitats there is a characteristic group of birds in summer. In the "dark" and "light" swamp areas the contrast between the two groups of birds is very marked. This does not mean that they are entirely different in the two communities. Some of the more adaptable birds occur in both the wet woods and the scrub, but even with these there is apt to be a marked difference in the abundance of the species as one moves from one habitat to the other. Some of the birds found in both areas are yellow-billed cuckoo, crested flycatcher, Carolina wren, red-eyed vireo, yellow-throat, hooded warbler, and cardinal. On the other hand, more species are found in only one of the two dominant habitats. The wood thrush, for example, is found only in the forest, or where the territory of the "lights" is fringed with a strip of trees along one of the canals. Other birds of the wet swamp are several of the woodpeckers, Acadian flycatcher, white-breasted nuthatch, prothonotary, Swainson's, parula, worm-eating, and Wayne's warblers, and Louisiana water-thrush. Birds found only or much more commonly in the "lights" are bobwhite, catbird (occasional in the wet swamp), house wren, blue-gray gnatcatcher, pine and prairie warblers, yellow-breasted chat, redwinged blackbird, indigo

bunting, towhee, chipping and field sparrows. So marked is the difference in the bird life of these two areas that by listening with his eyes shut one could easily know the kind of territory in which he stood.

The Dismal Swamp is a border line area where some races of birds reach their northward limit and where others reach the southward end of their ranges. Any species of animal life will vary to some extent in the different parts of its range. Where these variations are sufficiently well marked and stabilized the forms are recognized as subspecies or geographical races. Along the border between two such races there will, of course, be inter-breeding. The common song sparrow, being a widespread and very variable species, is a striking case of the formation of such races. It is represented on the continent by more than thirty races, the differences between some of these races being greater than differences between other separate species of sparrows. In most cases these geographical variations are quite small, the races being distinguishable only with the birds in hand.

The Dismal Swamp seems to be on almost the exact line of intergradation between the northern and southern downy woodpeckers. The downies of the Dismal Swamp have been identified at times as northern and at other times as southern. As a matter of fact, they are either, or neither. They are simply at the point where differences begin to show up, taking one tendency to the north and another to the south. This small area is the only territory in Virginia where the Athens yellowthroat breeds, the yellowthroats to the east around Back Bay and to the north across James River being the typical Maryland yellowthroat. Again, the Dismal Swamp is the extreme northern limit of the breeding range of Wayne's warbler. In order to settle some of these points and others like them it has been necessary to collect specimens and refer them to authorities like Dr. Alexander Wetmore for identification.

The faunal affinities of the Dismal Swamp are definitely with the country to the south rather than with that to the north. It is the most northeastern large extension of the palustrine forest type which covers so much of the coastal plain of the southeastern states. It is thus in the northeastern tip of the Austroriparian Life Zone, which is the humid or eastern division of the Lower Austral Zone. The theory of faunal zones has met with considerable criticism of late, but there are values in it, especially when it is supplemented within the zones by other ecological community concepts.

Water Birds in the Dismal Swamp

One of the paradoxical things about the Dismal Swamp is that throughout its thousand square miles of watery forest so few water birds nest. Many ducks and geese visit Lake Drummond in winter, but only the wood duck is known to nest in the area. It would not be surprising to find the mallard and the black duck nesting occasionally in the "lights" or on the edge of the swamp. While herons of several species, great blue, little blue, egret, and the night herons,

feed along its canals, and while there are heron rookeries nearby, only the green heron is generally distributed as a breeding bird. While sandpipers stop during the migrations, and the spotted sandpiper remains through May, we have no breeding records for any shore-birds. The woodcock, however, undoubtedly nests within the borders of the Dismal. If a naturalist could spend the entire year in the area, he would certainly see many unusual water bird visitors. An anhinga was seen at the Lake in August 1935 by Herbert Barber of the National Museum. In May 1932 I collected on Lake Drummond the first spring specimen of the northern phalarope for Virginia. Snaky-necked cormorants fly over the Lake in spring and fall. So few visits have been made here except in early summer that the list of such water birds is short. One of the most attractive sights of the region is that of a mother wood duck leading a flotilla of tiny young along a dark canal or in and out among the bushes at the edge of the Lake. When she gives her alarm call the little fellows put on power, fairly standing up on the water and leaving a shower of spray in their wake.

The Larger Birds

A characteristic and common bird of the Swamp, as of all wild places in the south, is the pileated woodpecker, so named from its *pileum*, or flaring red crest. Nearly as large as a crow, with a flashing black and white pattern in flight, it cannot be missed. Its slow beat on a dead limb makes as much noise as a man with an axe, and its call, a loud, hoarse "whucker, whucker, whucker" can be heard for a mile. Sometimes it can be seen flying out into the Lake to the old cypress stumps, where it feeds on the grubs of the wood beetles. Although the pileated likes wild country, particularly because it must have big timber for its operations, it is not particularly shy. I have had them come, when I was sitting quietly, within thirty feet and drill away at a stub as if I were not there. I have heard woodmen insist that the Dismal still has ivory-billed woodpeckers but as far back as 1892 Gilbert Pearson searched for them there in vain.

Occasionally, even in such daylight as may persist in the shade of the big forest of the swamp, one can hear the wild, maniacal laughter of a pair of barred owls. Their courtship is carried on with such gusto that the forest rings with their strange love calls. "Who, who cooks for you all?" they cry, according to the men who work in the swamp. Yet so silent are their wings that even at close range one cannot hear one of them fly past. These barred owls of the swamp are too far from human habitation to affect man's interests one way or the other, but even when they live near him their activities are beneficial, for their food consists largely of the rodents which damage his crops.

Vultures, both turkey and black, sail over the territory continually, notwithstanding Colonel Byrd's remarks. Not infrequently ospreys hunt over the Lake, while occasionally a bald eagle or a red-tailed hawk may be seen. Hawks are surprisingly uncom-

mon for such a region. Only the handsome red-shouldered hawk, with its rufous wing patches, its reddish underparts, and its heavily barred black and white tail, can be called fairly common. It is a graceful bird, whose call, as across the Swamp it screams "kill-yer, kill-yer, kill-yer," brings to the listener a welcome note of wild nature.

Wayne's Warbler

To the ornithologist the most interesting bird of the Dismal is not the barred owl with its dramatic caterwauling, nor the huge, ungainly great blue heron, nor the colorful pileated woodpecker, but a little bird to which the ordinary visitor would pay no attention. Even the earlier ornithologists did not realize that it could be found in the area. This is the Wayne's warbler, which is a southern coastal race of the wide-spread black-throated green warbler.

Wayne's warbler is one of those geographical races to which we have referred. The typical black-throated green warbler breeds from central Alberta east and south to northern New Jersey and in a narrow band along the mountains to northern Georgia. But there is another race of this species that breeds in a small area along the coast. In 1918 it was named Wayne's warbler in honor of Arthur Wayne, the South Carolina ornithologist who was its discoverer.

In the 1931 edition of the official check-list the range of this race was given as the "coastal district of South Carolina," even though the black-throated green warbler had been reported in summer from eastern North Carolina by Pearson and the Brimleys. The discovery in 1932 by Dr. William B. McIlwaine and the writer that the bird is a common breeder in the Dismal Swamp made it clear that the range extended all along the coast from Charleston to our swamp. On that trip to the Dismal we heard at least ten singing males and saw two pairs of adults feeding young birds on the wing.

An interesting point about Wayne's warbler is the fact that there is such a slight difference between it and the typical race in spite of the great gap between the ranges. Dr. Alexander Wetmore has stated that the alleged color differences do not hold good, and that the only dependable feature is that the southern race has a somewhat smaller and more slender bill. This would seem to indicate that the development of the differences between the two races is of comparatively recent origin.

In the late spring and early summer the wheezy but attractive song of Wayne's warbler, "zee, zee, zee, zee, zu, zee," is heard on all sides in the more deeply wooded parts of the Swamp. One of the best places to find the bird is along the trail from the reservation to the Portsmouth Ditch. In fact, I have seen it at the edge of the reservation itself. It can be heard along any of the canals in the large woods. In late May the young, when they have left the nests, may be seen buzzing like large bumblebees from tree to tree, followed by their frantic parents. Although we have not found a nest, eggs are certainly laid by late April.

Swainson's Warbler

This modest, lovely warbler was discovered in 1832 near Charleston, South Carolina, by the clergyman-ornithologist, Dr. John Bachman, who collaborated with Audubon. The bird was not seen again for fifty years, when in 1884 Arthur Wayne re-discovered it and collected a good supply of specimens. Although still considered an uncommon bird, it is now known to nest from Florida to southeastern Maryland; in the lowgrounds along the lower Mississippi and some of its tributaries; and also, strange to say, in some of the cool mountain valleys of the southern Appalachians.

Swainson's warbler was first reported in the Dismal Swamp by Dr. A. K. Fisher in 1895. In May 1908 a nest was found north of the James in Warwick County by Harold H. Bailey. This bird is so elusive that even in the Dismal Swamp it is not at all easy to find. The writer, familiar with the bird in its more southern haunts, has heard its song in the Dismal but has never seen the bird there. Ornithologists have made special trips to the swamp to see this species only to miss it. Swainson's warbler is unobtrusive but attractive in coloring, with brownish-olive back, snuff-colored cap, and yellowish-white underparts. The nest is a mass of leaves, fastened to canes or set in a tangle of vines on a low bush. As shy as is the bird, I once had the pleasure of looking at one on a nest at a distance of a few inches in a North Carolina swamp. This was at night, however, with the benefit of a flashlight.

Prothonotary Warbler

One of the most beautiful and at the same time one of the most common birds of the Dismal is the prothonotary warbler. The male is a rich orange all over except for the back and wings, which shade from greenish yellow to bluish gray. The jet-black eye and bill stand out sharply against the orange. The inner sides of the tail feathers are largely white, so that there are little flashes of white as the bird, darting in and out of the bushes, spreads its tail. As is usually the case with birds, the female is somewhat duller. Since the prothonotary loves the water and is rarely seen far from it, the Dismal Swamp is a natural haunt for it. The nest is placed in a small cavity, often within a few inches of the water and rarely more than 12 or 15 feet high. In and out among the trees above the dark stream the male chases the female like a golden shuttle in the nuptial flight, weaving a pattern of beauty and grace. In the dark swamp the bird seems to glow like a flame. The song is a clear, ringing and emphatic whistle, "sweet, sweet, sweet, sweet."

Parula Warbler

The parula warbler chooses a romantic nesting site. In the swinging festoons of Spanish moss it hollows out a little pouch, gathering the threads closer together and lining the pocket with plant down. Here it lays from three to five eggs, white and with a wreath of reddish markings around the larger end. Here, as summer comes, the young

swing back and forth in the breezes that blow across Lake Drummond. Its song is a buzzy trill, with a little explosion at the end. The parula was a much more common bird in this area in the old days when the moss was more abundant. Now it sometimes has to seek substitutes in the form of other mosses or even plant fibers.

Sparrows

One group of birds common in the southeastern United States is not well represented in the Dismal Swamp, the sparrows. There is just not much territory suited to them. Cardinals, of course, are quite common, as they show considerable tolerance in their choice of habitats. So are indigo buntings and towhees in the "lights," for here they find the type of thicket that they prefer. Usually a few chipping sparrows are found at the reservation, and occasional pairs of field sparrows along the Feeder Ditch. The open fields which sparrows like are almost absent in the Swamp. We have never listed a song sparrow there during the breeding season. In the winter, to be sure, the picture is different, for white-throated sparrows come in great numbers from the north to shelter in the forest undergrowth, while other sparrows share this territory with them. As compared with the country around the Swamp, however, this is not sparrow territory.

The Changing Dismal Swamp

This account must end on a sad note for all who love the wilderness, for there have been drastic changes in the Dismal Swamp within the memory of man and particularly within recent years. My first visit to the Dismal was fifty years ago in 1919. It is already a very different place from what I then saw.

The most obvious change is the cutting of the heavy forest. This began long ago when, for the purpose of getting out the timber, George Washington surveyed the canal which bears his name. As the decades passed, the cutting became more and more severe, the harvesting of second-growth trees following the destruction of the original timber. Since the cutting was too often followed by the accidental burning of wide areas, there are large sections of the northern and eastern parts of the Swamp in "lights" consisting of scrub growth and brier patches. With a better control of forest fires, some of the "lights" are now growing up in thin forest. Already there are trees forty feet high where twenty years ago there were only stumps and bushes, but this new forest does not have the character of the original Swamp.

Some of this clearing has been with the idea of developing arable land, but while the character of the northern third of the Swamp has been radically altered by the cutting of all the large timber, little of this land has been taken into cultivation. Along the eastern and southern edges a considerable amount of land has been put into cultivation. The western edge still follows the original boundary lines.

The greatest changes in the Swamp have followed the lowering of the water level. When Dr. T.

Gilbert Pearson, long head of the National Audubon Society, went into the southern side of the Swamp by boat in 1892 there were scarcely any places where it was possible to leave the boat and walk into the woods. "Frequent unsuccessful attempts were made to penetrate the wilderness around us," he wrote, "but the ground was everywhere so soft that, after getting off the slight bank of the canal, we invariably sank up to our knees in the peat. Even in the firmer places the ground could be shaken for a radius of eight or ten feet by simply springing the foot." I had the same experience in going in by the Washington Ditch in 1919 and again in 1932. Now, except in very wet weather, it is not difficult to walk away from the ditch banks or from the paths in the higher part of the Swamp. The George Washington Ditch in the western part of the Swamp has been almost closed up with fallen tree trunks, which helps the level here. In the northwestern section the Jericho Ditch has been so widened and deepened that a dry swamp is resulting. Much of the lowering of the water level seems to be due to the deepening of the Feeder Ditch and the constant withdrawal of the water from the Lake in order to keep up the depth for Inland Waterway travel in the George Washington Canal.

A minor change has come from the accessibility of the Swamp area. Not only fishermen, who have always penetrated the Swamp, but picnickers and visitors of all kinds now go up the Feeder Ditch to the Reservation and the Lake. This inevitably has its effect on the area. It does give an old Swamp devotee a certain pain to have to write his name in a visitor's book in a place which once only fishermen and woodsmen and true nature lovers knew.

The net result of all this is a drastic and unfortunate change in the nature of the Dismal Swamp. It is less wet and consequently less wild. More and more of its area has become wet forest rather than true palustrine territory. It is easier to get around in the Swamp; there is less and less to see when one gets there. There will probably always be limited areas of real swamp left, but if these changes continue, the Dismal Swamp as a great unit will inevitably lose its character. However one regrets to end on a note of pessimism, such is the situation.

Summary

BIRDS FOUND IN THE DISMAL SWAMP

- Anhinga, *Anhinga anhinga*
Blackbird, Redwinged, *Agelaius p. phoeniceus*
Bobwhite, *Colinus virginianus*
Bunting, Indigo, *Passerina cyanea*
Cardinal, *Richmondena c. cardinalis*
Catbird, *Dumetella carolinensis*
Chat, Yellow-breasted, *Icteria v. virens*
Chickadee, Carolina, *Parus c. carolinensis*
Cormorant, Double-crested, *Phalacrocorax a. auritus*
Cuckoo, Yellow-billed, *Coccyzus a. americanus*
Duck, Wood, *Aix sponsa*
Eagle, Bald, *Haliaeetus l. leucocephalus*

Egret, *Casmerodus albus egretta*
Flicker, Southern, *Colaptes a. auratus*
Flycatcher, Acadian, *Empidonax virescens*
Flycatcher, Great crested, *Myiarchus crinitus boreus*
Gnatcatcher, Blue-gray, *Poliopitta c. caerulea*
Hawk, Red-shouldered, *Buteo l. lineatus*
Hawk, Red-tailed, *Buteo jamaicensis borealis*
Heron, Great Blue, *Ardea h. herodius*
Heron, Green, *Butorides v. virescens*
Heron, Little Blue, *Florida c. caerulea*
Heron, Black-crowned Night, *Nycticorax nycticorax*
hoactli
Hummingbird, Ruby-throated, *Archilochus colubris*
Nuthatch, White-breasted, *Sitta carolinensis cookei*
Osprey, *Pandion haliaetus carolinensis*
Ovenbird, *Seiurus a. aurocapillus*
Owl, Barred, *Strix v. varia*
Phalarope, Northern, *Lobipes lobatus*
Redstart, American, *Setophaga r. ruticilla*
Robin, *Turdus migratorius*
Sandpiper, Spotted, *Actitis macularia*
Sapsucker, Yellow-bellied, *Sphyrapicus v. varius*
Sparrow, Chipping, *Spizella p. passerina*
Sparrow, Field, *Spizella p. pusilla*
Sparrow, Song, *Melospiza m. melodia*
Sparrow, White-throated, *Zonotrichia albicollis*
Swift, Chimney, *Chaetura pelasgica*
Thrush, Gray-cheeked, *Hylocichla minima bicknelli*
Thrush, Olive-backed, *Hylocichla ustulata swainsoni*
Thrush, Wood, *Hylocichla mustelina*
Veery, *Hylocichla f. fuscescens*
Vireo, Red-eyed, *Vireo olivaceus*
Vireo, White-eyed, *Vireo g. griseus*
Vulture, Black, *Coragyps a. atratus*
Vulture, Turkey, *Cathartes aura septentrionalis*
Warbler, Blackpoll, *Dendroica striata*
Warbler, Hooded, *Wilsonia citrina*
Warbler, Kentucky, *Oporornis formosus*

Warbler, Parula, *Parula americana*
Warbler, Pine, *Dendroica p. pinus*
Warbler, Prairie, *Dendroica d. discolor*
Warbler, Prothonotary, *Protonotaria citrea*
Warbler, Swainson's, *Lymnothlypis swainsonii*
Warbler, Wayne's, *Dendroica virens waynei*
Warbler, Worm-eating, *Helmithorus vermivorus*
Waterthrush, Louisiana, *Seiurus motacilla*
Waxwing, Cedar, *Bombycilla cedarorum*
Woodcock, American, *Philohela minor*
Woodpecker, Downy, *Dendrocopos p. pubescens*
Woodpecker, Hairy, *Dendrocopos villosus audubonii*
Woodpecker, Southern Pileated, *Dryocopus p. pileatus*
Woodpecker, Eastern Red-bellied, *Centurus c. carolinus*
Wren, Northern Carolina, *Thryothorus l. ludovicianus*
Wren, Eastern House, *Troglodytes a. aedon*
Yellowthroat, Athens, *Geothlypis trichas typhicola*
Yellowthroat, Maryland, *Geothlypis t. trichas*

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Forests and Forestry in the Dismal Swamp*

One of the earliest recorded descriptions of the forests of the Dismal Swamp may be found in a Journal of Colonel William Byrd written in the year 1728. At that time Colonel Byrd was preparing a petition to the King requesting permission to organize a land company to drain, cut timber and farm the Swamp. In one portion of the Journal he describes the denseness of the undergrowth and remarks that the reeds are ten to twelve feet high, and everywhere the "bamboe-byrs are intertwined so that they perpetually entangle the men's feet, causing them to walk with difficulty." His description continues "Among these reeds grows here and there a cypress, or white cedar, which last is commonly mistaken for the juniper. Towards the southend of it (Swamp) is a very large tract of reeds, without any trees at all growing amongst them, which being constantly green, and waving in the wind, is called the Green Sea. In many parts, especially on the borders, grows an evergreen shrub very plentifully, that goes by the name of gall-bush. It bears a berry which dyes a black colour, like the gall of an oak, from whence it borrows its name. Near the middle of the swamp the trees grow much thicker—the cypresses as well as the cedars. These being always green, and loaded with very large tops, are much exposed to the winds, and easily blown down in this boggy place where the soil is soft, and consequently affords but slender hold for the roots, that shoot into it. By these, the passage is in most places interrupted, they lying in heaps, and horsing on one another; nor is this all, for the snags left upon them point every way, and require the utmost caution to clamber over them. 'Tis remarkable that, towards the heart of this horrible desert, no beast or bird approaches, nor so much as an insect or reptile. This must happen, not so much from the moisture of the soil, but from the everlasting shade occasioned by the thick shrubs and bushes, so that the friendly beams of the sun can never penetrate them to warm the earth. Nor indeed do any birds care to fly over it, any more than they are said to do over the lake Avernus, for fear of the noisome exhalations that rise from this vast body of dirt and vastness. The noxious vapors infect the air round about, giving agues and other distempers to the neighboring inhabitants. On the western border of the Dismal is

a pine swamp above a mile in breadth, great part of which is covered with water knee deep; however, the bottom is firm, and though the pines growing upon it are very tall, yet they are not easily blown down by the wind, so that the people waded through part of it, without any other hindrance, but what the depth of water gave them. With all these disadvantages the Dismal is in many places pleasant to the eye, though disagreeable to the other senses, because of the perpetual verdure, which makes every season look like spring, and every month like May. This dreadful swamp was ever judged impassable, 'til the line dividing Virginia from North Carolina was conveyed in the year 1728, by the order of his late majesty. Nor would it have been practicable then, but by the benefit of an exceeding dry season, as well as by the invincible vigor and industry of those that undertook it. Some of the neighbors have lost themselves here for some days, but never had either the courage or the curiosity to advance very far. Nor can the difficulties of passing this inhospitable place be better conceived, than by the long time that was spent in doing it, even by men who were not altogether without apprehensions of being starved—they being no less than ten whole days in pushing on the line 15 miles, tho' they proceeded with all possible diligence and resolution, and besides, had no disaster to retard them."

From the context of the Journal, Colonel Byrd was apparently most familiar with the east and northeast portion of the Swamp.

Several years later, around 1765 to 1770, the Dismal Swamp Land Company was organized, and ultimately controlled some 40,000 acres of swamp land. George Washington was one of the principal stock holders. It appears that Washington was one of the more active owners and it was through his organizing ability that timber cutting began in the interior of the Swamp. It is learned by reading Washington's letters and writings that the Swamp abounded in the finest of pine, cypress and juniper. In a letter to Dr. Hugh Williamson on March 31, 1784, Washington refers to the frequent occurrence of large fallen timbers in the area.

From the writings of Robert Arnold (Dismal Swamp, 1888) who was a native of Suffolk, it is learned that in his trips to the Lake, the Swamp was thickly set with gum, pine, cypress and juniper.

To solve the problem of transportation Washington

* Editor's note: This is the second of a series of articles on the Dismal Swamp which will appear in the Virginia Journal of Science.

directed that a canal or "ditch" be dug from the Lake to the nearest high ground. Thus the "Washington Ditch" was dug, from the north end of the Lake westward to the Old Reese farm on the Edenton road about seven miles south of Suffolk. This Reese farm was just south of the present White Marsh School. From that point the lumber and other timber were hauled by wagon to a boat-land on the Nansemond River.

Several years later, in order to eliminate the long wagon haul, and to open up more timber area, the Jericho Ditch was dug. This ditch ran from the north end of the Lake to a point east of Suffolk (near the present water tank on the Norfolk and Western Railroad), and thence by a series of locks to Shingle Creek down to the Nansemond River. It is recorded that millions of feet of lumber were shipped annually, although this is probably an exaggerated statement.

As the new Nation grew so did the demand for lumber. Being located near a good shipping port the cutting of timber was heavier along the coast than inland, consequently the amount of lumbering in the Swamp increased. By the latter part of the Nineteenth Century and the early part of the Twentieth, several large lumber companies were formed and the cutting proceeded rapidly throughout the Swamp. Among the larger companies were the Richmond Cedar Works with large holdings in the eastern and southeastern portion, the John L. Roper Company, and others, with holdings in the eastern and northeastern sections, while the Camp Manufacturing Company of Franklin, Virginia, acquired a large ownership in the western half of the Swamp. Up until about 1937, some twenty thousand acres of virgin swamp timber located in the southwest side north of the Virginia line remained uncut. Since then this area has been logged off, so that today there remains practically no areas in the Swamp which have not been cut over once or more.

A large variety of timber trees occur in this area, among them being loblolly and pond pine, black and tupelo gum, tulip poplar, cypress, southern white cedar oftentimes called juniper, red maple and several species of oak, together with numerous shrub species such as greenbay, redbay, and wax myrtle. These species are very sensitive to a slight difference in elevation. The loblolly grows only on the drier portions while pond pine grows where the ground remains damp most of the time. The gums and cypress are found in the wet locations.

At present there are large areas in the Swamp which support only a growth of reeds and a type of water grass. Around the edge of these areas is generally found a growth of maple and gum species, while the zone ring consists of pine or white cedar. These extensive non-tree growing areas are locally called "lights." Characteristic lights may be observed along the Portsmouth-Elizabeth City highway, Route #17, in the area south of Wallacetown and the Virginia Division of Forestry fire lookout tower at Angle Siding and south of the North Carolina-Virginia state line. Another typical light may be observed south of the Suffolk-Portsmouth highway, Route

#58, about seven miles east of Suffolk. Still others may be observed along highway Route #158 between South Mills and Sunbury.

The origin of these "lights" is attributed to various causes. It is the opinion of this writer that most of them were caused by fire. While on fire control work in the Swamp at various times old stumps and logs have been found far out in these lights buried underneath the peat. This evidence strongly supports the thesis that the entire area at one time supported a stand of timber except possibly portions of the Green Sea. Following timber-cutting, fire burned the slash and repeated fires in drought periods have successively lowered the surface area so that the better tree species, and in many places even shrubby vegetation, have been unable to re-establish themselves due to the water which stands in these depressions during times of normal weather. If fire could be kept out for long enough time, nature would gradually build up the level of these areas with decayed grasses, mosses and other vegetation until a height above normal water level had been attained so that a pine or cedar seedling could become established.

The above observation is supported by the conditions now existent on the northern edges of the big light south of Route #58 between Suffolk and Portsmouth, just west of the Norfolk-Nansemond county line. The border line between the water grasses and the stand of pond pine saplings is distinctly marked. Inspection at a time when the water table is normal will reveal that in the sharp transition zone the elevation where the pines are growing is slightly higher.

On the north of highway #58, less than one-eighth mile distant from the water grass zone, there occurs a dense stand of rapidly growing pond pine now some thirty to forty feet in height and four to six inches in diameter. Very little fire has occurred in this area on the north of the road since it was logged off about 1915, while repeated fires have occurred south of the highway and the Seaboard and Virginian railroads. These stands of pine are evidence that water line and fire control are factors determining the establishment and growth of pine. From time to time foresters have noted and commented that the normal late fall, winter and early spring water level has been the factor limiting the establishment of pine in numerous of the light areas. They have emphasized that pine cannot be expected until Nature has had sufficient time to build up the depressions with the annual growth and decay of vegetation, unless aided by the ingenuity of man.

Study shows that pine, juniper, gum or maple seed which alights on points such as upturned roots or other hummocks which are slightly higher than the water level will, during the spring or early summer germinate and live until, in the fall and winter, when the water rises sufficiently to cover them, after which the young seedlings drown out. In some instances the seedlings may be a year or more old before the water, during a prolonged wet season, rises enough to smother them.

The largest owner of land in the Swamp, the Camp Manufacturing Company of Franklin, Virginia, decided, after considerable study, that an attempt to control the water level was possible and practical. Working with the drainage division of the Soil Conservation Service, a system of ditch locations have been devised with the purpose of draining surplus water from the lowest "light" areas during wet periods of the year. A simple yet effective system of gates was constructed in each ditch. During the high water season of late fall, winter and early spring, the gates will be open so that surplus surface water will drain off. As dry weather approaches, the gates will be closed so that water will be held in the area. During periods of drought such as occurred during the late summer and fall of 1952 and 1953, it may be expected that the Swamp will dry out even though the locks are closed. Generally, the droughts do not kill much timber; fire during these periods is the killer.

It is believed this system of ditches and gates will lower the water table sufficiently during the wet periods to enable the small newly germinated seedlings of pine and cedar to survive, especially those which germinate on upturned roots, hummocks and other places which rise slightly above the lowest water levels.

Drainage ditches, period of cutting and fire have determined, to a considerable extent, the character of the present forest cover of various sections of the Swamp. It has been a characteristic of past fires that as they burned from the "lights" into the stand of mature timber, the fire would oftentimes gradually die out due to the moister condition and less rapid air circulation found underneath the large trees. In newly cut-over areas, fire has inevitably burned the heavy slash, except in the southwestern portions of the Swamp in Virginia and repeated fires have changed the character of the ground surface and the resulting vegetative cover.

As noted elsewhere, the west and southwest portion of the Swamp, particularly that portion south of the Washington ditch, supported comparatively virgin timber until 1937. Logging left an extremely heavy slash. Fortunately, no widespread fire has yet occurred in this area. It is returning to a heavy second-growth of pine, gum, maple and some oak. If, by good fortune, fire can be kept out, the area will support a fine stand of second-growth timber of a size suitable for cutting by the year 1990 to 2000.

This area was logged by railroad and steam donkey engine yards during 1937-44. Much of the railroad was built on pilings driven in the Swamp which supported the tie caps and rails. Even on favorable areas, the roadbed consisted of a heavy under network of trees, logs and brush. Most of the pine was of excellent quality. Many trees yielded 64 and 80 linear feet of logs with the larger trees being up to 45 inches in diameter. Many of the cypress, oak, and gums were even larger in diameter, but were quite defective. The gum, especially, was affected by heart rot. It was not unusual to see an entire car load of gum logs with every log showing a decay hole from one end to the other.

Extensive and widespread forest fires have materially changed the original type of tree growth to the type of vegetative cover now existent in many sections of the Swamp. Evidence and history show that the portion of the Swamp lying to the east and southeast and northeast of the Lake has been burned more frequently and heavier than the western and southwestern portions.

A trip over the Swamp reveals that the timber types present a heterogeneous pattern. West of a north-south line through the center of Lake Drummond the second-growth timber is fairly good. Much of the timber is second-growth hardwoods with pine intermixed, although there are considerable areas of pure pine. In some areas the pine and hardwood will range up to approximately 16 inches in diameter. At the time of logging many islands of younger timber were left standing due to the inability of the company to log these stands profitably.

Both north and south of the Lake are islands or isolated areas of white cedar, ranging from the small seedling up to saplings fifteen to twenty feet in height. Probably the best stands of young cedar are to be found south and southeast of the Lake. Little merchantable cedar is still available. This species appears to be especially selective in its requirements, which accounts for it growing in isolated islands. Experience shows that following the cutting of a cedar stand, a heavy fire during a dry or drought summer or fall will pretty well preclude a good stand of cedar production since the fire burns sufficiently deep to destroy the seed stored in the peat. A further discussion of this valuable, and scarce, species will be given later.

Along the natural drainage, there occurs the gum swamps. From the air these are readily located and form no fixed pattern, but meander along the natural drainage. These gum swamps vary in width from a hundred yards up to a mile or more. The timber composition varies with the wetness of the swamp. In the narrower ones the tree species may be only clumps of small maples, bays, cypress, and gums, while the larger ones may contain great hollow snags of cypress, gum, water oaks and associated species. In normal weather these larger swamps are wet enough to stop the advance of a fire, but in a drought area when the peat which is always present dries sufficiently to burn, the damage to the trees is heavy.

From a forest replacement point of view, the problem areas are those vast expanses of "lights" where grows no tree, or at the best an occasional pine, generally a scrubby pond pine. As one flies over the Swamp or inspects an air photograph, these treeless areas will be observed throughout the Swamp, irregular in outline and extending for miles.

It will be observed that a zone of pine, mixed loblolly and pond, occurs along the ditch and canal banks. It is along these waterways that some of the pine has been able to survive the fires. Some of these pines are veteran remnants of a former stand, while others are second-growth just reaching the seed-bearing age. These are the trees which have furnished the seed for the younger pines which are

valiantly extending their skirmish lines into the reed and grass areas.

Typical areas of the above condition may be observed for miles along the Dismal Swamp Canal along which highway Route #17 runs from Portsmouth to Elizabeth City, the Portsmouth Ditch and Hodge's Ditch. It may also be noted along the several canals in both North Carolina and Virginia. The view from the highway is often deceptive, as there is generally a fringe of good trees along the canal banks, which screens the prevailing type and condition of vegetation.

Nature's ecological succession process is well portrayed in this struggle for survival. From a plane, a convenient tree top or an occasional open place along the canal bank, one readily observes the extension of the more dominant and climax type. The pine tree zone may extend several hundred yards from the ditch bank and gradually thin out to a zone mixture of small gum and maple if the location is damp, or to mixed pine and wax myrtle if it is drier and finally to the zone of reeds, water gums, and other weeds. Where trees become established they grow rapidly.

The Dismal Swamp is the only place in Virginia where the southern white cedar (*Chamaecyparis thyoides*) is found. It grows naturally both on the Virginia and North Carolina sides of the Swamp. This species is known also as white cedar, juniper, swamp cedar and post cedar. Since this tree occurs nowhere else within the State, it is believed apropos to describe the species in some detail.

Southern white cedar is an extremely valuable tree. Its lumber is highly prized for use in all places where decay resistant wood is necessary. Typical uses are for shingles, water tubs, boat lumber, poles, and posts.

In the Swamp, the cedar grows in even-aged dense stands. This type of growth produces long, clear tree boles of good form. Pure stands occur on areas of swamp peat with a high acidity overlying a sandy subsoil, but as the quantity of silt and clay in the underlying soil increases, the proportion of swamp hardwoods increases until the cedar can no longer compete with them. Repeated fires which, in effect, reduce the peat in the juniper glades or islands tend to increase the amount of hardwoods, until in some areas the cedar is crowded out of the new stand. Gradually the area supporting cedar is decreasing, due primarily to fire and clear-cutting.

Mature white cedar is one of the most graceful and symmetrical conifers of eastern North America. The terminal shoots and branch tips lack the rigidity common to spruce, fir and pines, and the crown is formed of slender, horizontal branches somewhat pendant sprays of branchlets and twigs.

The leaves are rigid, sharp-pointed, horizontally spread along the twig, are about one-fourth inch in length and light green in color. The flowers appear in early spring, usually in March or April. The male and female flowers are produced separately although on the same tree. Seeds are small, light brown and run from 400,000 to 500,000 per pound. They are dispersed by the wind, as they have a

small membranous wing attached to each seed which comes from a small six-scaled cone.

The root system is shallow, being found primarily in the top one to two feet of peat. As a result the tree is not windfirm and is apt to windthrow unless grown in thick stands.

The bark is a light reddish brown, rather fibrous and varies in thickness from 3/4 to 1 inch at the stump to 1/10 inch at the tip top shoot.

Since cedar is a moisture-loving tree, standing water is often found in the interior of the cedar glades. In this respect it is similar to the gum swamps, but in the gum swamps the water generally has some movement, is fresher to the taste and is less acid. In cedar glades the water is usually still, stagnant, not fit to drink, is exceedingly acid and of a dark coffee-brown color.

In early growth the species is very tolerant to light, but not sufficiently so to survive under a dense stand of mature cedar. As the seedling grows older it is more demanding in its light requirements as is evidenced by its development in pure stands.

Fortunately, few insect enemies attack the cedar. Heart rot (*trametes* sp.) is the most important fungus destroying mature cedar wood in the standing tree.

Several characteristics favor the natural reproduction of this swamp-loving tree. Seed production begins at the early age of 5 to 10 years. The cone matures early in the fall, and is released promptly after the cone matures. The seed are light and spread over large areas. Evidence indicates that only a small amount of the seed is consumed by birds and rodents.

Except in extremely thick stands the young cedar grow quite rapidly, although not so fast as the intolerant pond pine with which it is sometimes associated. When growing too densely the stand stagmates.

Careful studies made of southern white cedar indicate that in the average naturally thick stand, fifty years old, the average height of the dominant trees will approach fifty feet, while the average diameter breast high will approximate 5.4 inches. Such a stand will contain about 1500 stems, large and small, and will cut out about 40 cords of wood or about 5500 board feet as measured by the International $\frac{1}{4}$ inch Log Rule. This growth rate is not as good as loblolly pine, which on average soils will grow about 70 feet in height, with an average breast high diameter of 9.4 inches and will produce approximately 50 cords of merchantable wood.

Pond pine (*Pinus rigida* var. *serotina*) is found throughout the Swamp. It is only in the Dismal Swamp that this species is found to any extent in Virginia. It is rather widespread throughout eastern North Carolina as well as that portion of the Swamp which lies in the State. According to taxonomists Pond pine is rather closely related to pitch pine, which is commonly found in the western Piedmont and mountainous areas of Virginia. However, in general appearance and to the view of the average person, it resembles loblolly pine and is oftentimes considered one and the same. The crown

of pond pine has a more open appearance than loblolly. There is a tendency for the needle clusters to be close to the sturdy twigs. The six to eight inch long needles are in clusters of three and occasionally four, marked by numerous rows of stomata on the three triangular faces. They are shed during their third and fourth years. As in all other pines, the male and female flowers are on the same tree.

The unopened, mature cones are 2½ to 4 inches long, about 1½ inches in diameter near the base and have the general shape of an inverted cone. Many of the cones tend to curve toward the limb or twig to which they are attached. Unlike most other eastern pines, all of the cones do not open the first season. Some of them stay on the trees for years. Oftentimes the scales remain closed until opened by the heat of a fire. Over the years Nature has evolved this method of supplying a seed source to heavily burned over areas.

Pond pine can withstand repeated fires and still survive. Its bark is thick which insulates the cambium from the destroying heat. Oftentimes, after a fire, a stand of pond pine saplings will be devoid of all green leaves and will exhibit every evidence of being completely killed. In many instances, a few weeks will find new needles appearing from the adventitious buds along the main trunk and larger limbs. This sprouting is more pronounced in pond pine than any others found in the State, although shortleaf pine does sprout to some extent. Mature trees reach a diameter of 18 to 30 inches and a height of 80 to 100 feet. As with all other trees, the fertility of the soil, moisture and frequency of fire damage determines the ultimate size the tree will reach.

Cypress (*Taxodium distichum*) is found in and near the watercourses and around Lake Drummond. Old snags indicate that some of the cypress reached a diameter of five feet above the root swell and a height of one hundred twenty feet. Cypress is especially demanding in the conditions under which it reproduces itself. Water level conditions must be just right both before and following germination. The unfortunate result is that cypress has decreased as a component of the second growth timber.

Loblolly pine is found on the drier or so-called ridges which have an elevation of 18 to 20 inches higher than general swamp level. It grows rapidly and is a desirable tree.

Forest fire is the key to the past, present and future of timber growth and forestry in the Dismal Swamp. It is believed that the control of fires is more important than the type of forest cutting practices used. Of course, the control of fire together with the proper cutting practices is the ideal.

As noted earlier, fire has burned often and hard over much of the Swamp. It appears that the eastern, especially the northeastern part has been burned hardest. Records, and the memories of the older citizens concerned with logging in the Swamp almost always refer to the large fires which have occurred. Many of these fires have burned over thousands of acres before being stopped, generally by weather conditions.

Causes of fires are numerous. Campfires, cigarettes and discarded lighted and smoking matches have probably been the chief causes. Some fires have undoubtedly escaped from logging jobs and from railroads. Occasionally a fire is caused by lightning, but not often. During World War II some fires were caused by the use of flares, bombs and tracer ammunition.

It is believed that fires sometimes originate from swamp water "still" operations which are frequently conducted within the outer borders of the Swamp. The writer recalls being on a fire during the dry summer of 1930, located near the Nansemond-Norfolk County line just south of the Virginian and Seaboard Air Line railroads. At that time the City of Portsmouth secured a part of its water through a 24 to 30 inch wooden conduit pipe bound around every 9 or 10 inches with iron rods, which ran parallel and on the south side of the railroads. While walking along or on top this water pipe a wooden hand plug was noted in the pipe at a point where a well defined path went southward into the dense undergrowth. Suspicion and curiosity were immediately aroused. To satisfy both emotions, the path was curiously and hesitantly followed for about two hundred feet where a fair-sized opening had been cleared of brush and reeds. In the opening were several mash boxes with mash well ripened, a twenty-gallon still, cans and other necessary equipment. Every still must have water, which was a scarce commodity out in that dry reed patch. The operators had ingeniously solved their problem by running an ordinary garden water hose out to the water main, bored a hole and tapped in the hose. When not in use the hose was withdrawn from the water main and the path. The hole was plugged so as not to attract the attention of passersby to the water spouting from the hole. To further reduce attention the plug was fashioned from well weathered wood that matched closely the color of the water main.

Among the crew of men who erected the forest fire tower east of Suffolk in 1928 were two Negro men, Josh and Mose. One morning they were overheard discussing the bear they had caught. Both were reluctant to go into any detail as to how they had captured a bear. Fact is, some of the crew doubted they had caught a bear, but after work a trip by the home of Mose proved they had a fair size bear chained to a stake with a heavy dog chain. Within the next couple of days it developed that Josh and Mose just happened—no special reason—to be walking around out in a certain location in the edge of the Swamp and found this bear staggering around in a helpless condition. By a little fast maneuvering and foot action Josh and Mose had tied the bear's feet and later led him out of the Swamp by the chain around his neck. Adroit questioning revealed that the bear had eaten too heavily from a box of nearby over-ripe mash and was just plain drunk, when Josh and Mose "just happened" to be strolling out there in the brush and reeds wet with the dew of early morning.

In times past numerous fire damage lawsuits have

been fought through the Norfolk and Nansemond courts. Probably the most recent large fire damage lawsuit concerned the Norfolk and Western Railroad Company and several landowners over a fire which burned south of the railroad in October and November in 1930.

Previous to 1927 there had been little to no coordinated attempts by the landowners and public agencies to prevent and control fires in the Swamp. In 1927 the counties, the State through the forest service, and several of the landowners combined their efforts in Virginia to prevent and suppress fires. The counties agreed to defray certain suppression costs, the Forest Service was to organize and manage the project with the assistance of the landowners. An association was formed by several of the larger owners who paid a few cents per acre into the Association Treasure which in turn was made available to the Forest Service for use in purchasing equipment and employing personnel.

During 1928 two 100-foot inside stairway Aermotor steel lookout towers were purchased. The towers were equipped with a 7 by 7 foot completely enclosed metal cab on top of the tower. One tower was erected just east of Suffolk and north of the old Suffolk-Portsmouth highway on property belonging to the Camp Manufacturing Company. The other tower was located in the east portion of the Swamp at Angle Siding, at a point about three miles north of the Virginia-North Carolina line and west of the Portsmouth-Elizabeth City Highway and west of the Dismal Swamp Canal. Ready access to this tower was removed when the railroad was abandoned about 1938 and the bridge over the canal was demolished. At present a rowboat is used to cross the 60 feet of water in the canal. Both towers are still standing, are in good condition and are still used.

During the war in 1943 a third tower of a similar type was erected just north of Bowers Hill near the junction of Highways 58, 460, 13, and 191. On reasonably clear days these three towers afford adequate detection coverage, either by direct observation or by triangulation on a series of maps in the towers or in the office of the District Forester, whose office is connected with the towers by telephone lines.

During the war, the North Carolina Forest Service established a lookout point on the roof of the Virginia Dare Hotel in Elizabeth City. Lookout services between the two states were closely coordinated.

In late 1928 and early 1929 a forest warden system was organized and a limited amount of hand tools were purchased. Included was one Pacific Marine, high pressure water pump, throwing approximately 60 gallons per minute and approximately 2000 feet of 1 $\frac{1}{4}$ inch liner hose.

Despite numerous fires around the edges of the Swamp and a few in the interior, the area burned was held to a reasonably low figure until the late summer and fall of 1930. It will be recalled that 1930 was the year of the severe drought. During late summer several fires occurred which burned areas from 1000 to 1500 acres per fire.

On October 4 a fire escaped in the interior of the

Swamp, near the fifteen mile post and south of the Norfolk and Western Railroad. Fanned by a strong northerly wind the fire rapidly spread southward. Despite the combined efforts of all interested companies and agencies the fire continued to burn until early November, when it was extinguished by a series of rains. This fire burned over approximately 10,500 acres. Suppression costs were heavy and drained the funds available for such work.

In the spring of 1931, another fire escaped from a man burning a ditch bank, west of the Canal, on the east side of the Swamp near Wallacetown. Again, despite combined efforts, the fire burned over an estimated 12,000 acres.

In May 1932, most parties concerned recognized that the cost and facilities for adequate protection of the Swamp were not equal to the task. By mutual agreement, forest fire protection in the Dismal Swamp was abandoned. The equipment was divided equitably between the counties, association and Forest Service.

From 1932 until late 1941 fires occurred off and on and burned at will. The spring and summer of 1941 were dry, even approaching drought conditions. Fires burned continually in both Virginia and North Carolina. As nearly as the writer can recollect, practically all the Swamp in Virginia was burned east of the Norfolk-Nansemond county line.

With the approach of war, and finally the declaration of war, the continuous pall of smoke constituted a national hazard. Thousands of acres of peat were on fire which added a continuous volume of strong acrid smoke to the smoke of the surface fires. At times, especially after midnight and early morning, the smoke was so dense that all air, ship, railroad and highway traffic was seriously hampered. Offshore defense activities, especially anti-submarine patrol, were at a standstill during certain periods. The Army and Navy requested the Governors of North Carolina and Virginia to institute such steps as were necessary to eliminate the smoke hazard. At a conference with the officials, the two State Forest Services were of the opinion that the fires could be controlled if sufficient funds were available to provide the necessary equipment and personnel. In addition to the State money available, there were made available sufficient funds from a National Defense Fund to provide the necessary personnel and equipment. Deeply entrenched peat fires along the Feeder Ditch were worked on from August until the next April before final control was effected.

Detailed fire prevention and suppression plans were devised and carefully coordinated between the two states. Effective fire control was provided until the end of the war.

Following the war, in 1946 the forest fire control organization was dissolved as a war measure. Certain of the counties in North Carolina abandoned entirely efforts to control fires in the Swamp. In Virginia the counties and State Forest Service continued approximately the then existent type of organization.

During the period 1946 to January 1953 the

State-sponsored fire prevention and control proved effective. Much new equipment was procured. Heavy extra wide truck caterpillar type tractors with a specially designed fire line plow weighing more than a ton are now used. Wherever the ground is stable enough to permit passage of these plow units a fairly good fire line can be made.

A real test of the organization came in late October of 1952. A fire again originated near the 15 mile post south of the Norfolk & Western railroad. Joint action by the Camp Manufacturing Company and the Virginia Forest Service soon had three of the heavy tractor plow units on the job. After ten days and nights of struggle the fire was controlled with about 1500 acres burned.

Fire fighting in this area is both difficult and dangerous. Today, even as in the days of Colonel William Byrd, it is impossible to make much progress in moving through the almost impenetrable jungle of reeds, shrubs, and briars. Surface fires, on a bright day with low humidity, driven by the strong coastal winds move fast, furious and with such a great wall of fire that great care must be taken so the fire fighters and equipment will not be caught and burned.

Once a fire line is finally plowed or cut around a fire there is great and continuous danger that particles of burning leaves, moss, bark or grass will blow overhead and again start up the fire.

A dangerous condition found only in the swamp area is a so-called "reburn." Oftentimes, with the shifting winds, the reeds and green leaves of the bay, reeds and wax myrtle are not completely consumed by the flames, but are burned sufficiently to cause them to dry out within a few days. During the intervening time until all interior fire is dead out, some bright windy day a few smouldering peat fires will burn off a few reeds or a myrtle bush which will fall over into the smouldering peat and blaze up with fire, which in turn, fanned by the high wind, will spread to other reeds until soon there is a raging fire burning back over an area burned a few days previously. Oftentimes this reburn spreads a new fire across established fire lines.

On some fires which occur near the canals it is possible to use specially designed motor driven water pumps with hundreds of feet of two inch linen hose. Oftentimes, if the water table is not too low, it is possible to dynamite or dig wells from which water can be drawn.

Most every swamp surface fire will set fire to areas of peat. This burning peat, which burns in a slow, smouldering, fiercely hot fire must be watered dead out; for just so long as there is one particle afire, there exists the danger of a new surface fire.

The peat fires are extremely damaging to the timber. The writer well recalls the peat fires of 1930, 1941, and others where the fire moving along twenty to fifty feet a day, and one to two feet deep, would literally burn the roots off the standing trees, causing them to fall over in a cross stick pattern. The result was total destruction and, later, an impenetrable mass of tree tops, and later briars, vines, and reeds.

Peat fires in ditch banks are extremely difficult to drown out. At the time the canals and ditches were dug, the top layer of dug earth was piled along the ditch bank, and where peat was present, this resulted in a double thickness of peat. This over layer of solid earth acts as a roof. Thus, when a fire burns in a canal or ditch bank, the fire is often three to six feet under ground. To extinguish such a fire requires days, sometimes weeks, of hard work and tremendous quantities of water. The writer knows of one fire which burned in a ditch bank for eighteen months before finally burning itself out.

An understatement in describing the human relationship of fire fighting in this area is that it is a hard, disagreeable, dangerous, dirty, and often thankless job.

The past two decades have witnessed several local movements to create within the Swamp area a National Forest or a National Wildlife Sanctuary. Probably the most intensive of these movements was the one initiated during 1944 to 1946 with the object of creating a National Forest. A local committee prevailed upon the Virginia Department of Conservation and Development through its division of Forest Service to assist in securing data on ownership, acreage, availability and other data. Many of the major land owners were interviewed, most of whom evidenced interest in the sale of their property. At least two exploratory meetings were held with members of the North Carolina Conservation Department in an effort to coordinate activities. Negotiations reached a point where the U. S. Forest Service sent representatives to inspect the area and also interview several of the larger land owners concerning availability of the land and possible sale price. About that time a large timber holding company began negotiations with the purpose of acquiring long time growth and cutting rights on a large piece of property in the south end of the Swamp. As the time approached for other land owners to name a sale price, more and more of them decided that with increasing timber prices they were not interested in selling. Thus a well conceived and worthwhile movement to create a publicly owned area of the Swamp died aborning.

What does the future hold for the forests of the Dismal Swamp?

The two basic keys to the future are forest fire control and the use of sound forestry methods.

There is irrefutable evidence that, at the time of the arrival of the white man, most of the Swamp supported dense stands of timber. True, much of it was overmature and consequently there was much decay and cull. Since then it has been ruthlessly cut over, followed by widespread destructive fires.

But, in a large measure, the timber producing potential of the soil remains. Climate and soil are conducive to the rapid volume growth of the valuable native tree species.

The Swamp area is capable of producing large quantities of valuable pulpwood, sawlogs and veneer logs, together with cedar poles. It is located to nearby markets, many of which process the raw material to a finished product, thereby affording a maximum of

employment, wages, and trade within the area for each unit of wood volume produced. This fact alone gives added value of this timber-growing area to the local community.

Modern logging and earth moving machinery, together with future improvements, will make harvesting the future periodic timber crop less difficult. Although the logging costs will increase, it is confidently believed the increased value of the trees on the stump will make the operation profitable.

Because of the dense ground cover, and difficulty of road construction, the absence of a smooth beach at Lake Drummond and the steepness of the canal banks, it is probable the chief recreation value will be hunting and some fishing. It would not seem that this type of recreational use should be incompatible with the growing and harvesting of the timber crop. On the contrary, it would seem there should be several definite advantages.

Even though fires were eliminated, it will take several decades before a satisfactory stand of forest tree species can be established in all of the "lights." Much planting would have to be done. Possibly the direct seeding of pine might, in places, prove effective. This is especially true since the recent discovery that the deadly poison tetramine may be successfully used in protecting the pine seed from destruction by rodents and birds. Controlled water control projects, such as the one in progress in portions of the west side of the Swamp, will be helpful.

If we can look far enough in the future to visualize a reasonably full stand of timber, we can then hope

the landowners will be sufficiently wise to cut the timber in a manner that will retain a timber ground cover and a source of seed for the new crop.

Mother Nature will accomplish wonders in recovering denuded areas with the climax vegetative type, if man will only not divert her in this case by fire and destructive cutting.

In the final analysis, the immediate factor which will determine the characteristics of the forest cover existent in the Dismal Swamp in the year 2000 A.D. and 2500 A.D. is fire.

Fire control logically and practically divides into two phases, first, fire prevention and second, fire suppression. No matter the amount of money, within any reasonable limits, the landowners and public agencies might spend to perfect a fire suppression organization, it is inevitable that sooner or later, when weather conditions are right, an occasional fire would get beyond immediate control and burn over a large area.

In the prevention of fires the landowners and public agencies can, and undoubtedly will, continue to assume leadership. Again, no amount of money spent by the landowners and public agencies can prevent all fires.

The prevention of fires in the Dismal Swamp rests finally with those people who live adjacent to and travel through the Swamp, whether it be for business, fishing, hunting, or sightseeing. Thus, the type of forest cover which will ultimately prevail in the Swamp definitely rests in the hands of those who live by it and those who use it.

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An Unusual Infection of *Polystoma nearcticum* (Paul, 1938)

Abstract—A monogenetic trematode, *Polystoma nearcticum* (Paul, 1938), normally infecting the urinary bladder of certain tree frogs, was recovered from the anterior portion of the large intestine of the gray tree frog *Hyla versicolor versicolor* (Le Conte). Additional collections were made to compare the sites of infection with the morphology of the mature trematodes. Since no trematodes were found outside the urinary bladder in subsequent examinations, and the comparative morphology of the trematodes from the two infection sites indicates normal development, it would appear that this is an unusual case of this polystomatid inhabiting the alimentary canal.

Introduction and Methods

Following a survey of parasites of salientia from Pocahontas State Park in Chesterfield County, Virginia, Campbell (1) reported the recovery of a specimen of *Polystoma nearcticum* (Paul, 1938) from *Hyla versicolor versicolor* (Le Conte). This parasite, normally inhabiting the urinary bladder of certain tree frogs, was recovered from the large intestine. Further collections were made in Gloucester County, Virginia during the summer of 1967. The purpose of this collection was threefold: first, to determine if additional adults of *P. nearcticum* could be found infecting sites other than the urinary system of *H. v. versicolor*; secondly, to obtain mature worms from the urinary bladder for morphological comparison; and thirdly, to determine if adults of *H. cinerea cinerea* (Schneider) in Virginia also harbor this parasite.

Adults of 12 *H. v. versicolor* and 14 *H. c. cinerea* were collected within the environs of Haynes Mill Pond, Gloucester County. Specimens were collected by hand with the aid of a battery powered spotlight and placed in a covered plastic container. All specimens were kept alive and examined within 24 hrs. for helminth parasites. The alimentary tract was carefully separated from the urinary bladder, subdivided into its respective topographic portions, and placed in individual Syracuse watchglasses containing 0.65% saline solution. Polystomes were removed, relaxed in a saturated solution of chloretoe, and fixed in A.F.A. Wholomounts were stained in Ehrlich's acid hematoxylin.

Results

Of the eight *P. nearcticum* recovered, all were obtained from the urinary bladders in five of the

12 *H. v. versicolor* examined. Five of the polystomes were mature. Although no specimens were recovered from *H. c. cinerea* it is likely that this infection occurs in this area since *H. c. cinerea* may also serve as a host. It may be noteworthy that although these two species of known hosts were collected within 100 yds. of each other, *H. v. versicolor* sustained a high percentage of infection (41%) whereas *H. c. cinerea* sustained none (0%). It is possible that this difference is due to the fact that *H. v. versicolor* breeds in shallow temporary surface water while *H. c. cinerea* breeds in larger, more permanent bodies of water. If this were the case, it would seem that the chances of the infective oncomiracidium finding a host in the shallower, more confined body of water, would be much greater. The author realizes that the sample size of *H. c. cinerea* is relatively small in comparison to the total population at the pond, but if the two species were using the same pond for breeding one would expect to find one or more infected *H. c. cinerea* out of 14 in a random sample. This does not seem improbable since a smaller number of *H. v. versicolor* (2) harbored an infection of 41%.

Comparison of the specimens from the urinary bladder with the single adult specimen from the large intestine revealed the latter specimen to appear normal and fully developed except that it is slightly smaller. No eggs are present in the specimen from the large intestine although sperm are evident in the vas deferens and the ovary is fully developed. Only two of the eight specimens recovered from the urinary bladder were gravid.

Discussion

Monogenetic trematodes are primarily ectoparasites of cold-blooded vertebrates. However, some instances of endoparasitism have been recorded: several species of *Calicotyle* have invaded the rectum, rectal glands, and oviducts of certain rays (2-4); *Dictyocotyle coelica* Nybelin, from the coelomic cavity of certain rays (5-7); *Acolpenteron uterocoeles* Fischthal and Allison, from the ureters of black basses (8); *Enterogyrus cichlidarum* Paperna, from the intestine of some cichlid fishes (9); and a dactylogyrid from the esophagus of the marine teleost *Sebastes madurensis* (10).

Several polystomatids have long been known to

parasitize the buccal cavities and urinary bladders of amphibians and chelonians. However, few instances have been cited of these parasites infecting internal sites other than the urinary bladder. Members of the genus *Polystoma*, infecting the urinary bladders of amphibians, normally migrate as larvae, during the metamorphosis of the tadpole, from the gills through the length of the gut to the cloaca and thence to the newly formed urinary bladder where they mature. The gut of the tadpole is temporarily emptied during metamorphosis, presumably facilitating migration. Williams (11) described a case of abnormal migration of the larvae of the European *P. integrinum* Frohl on a *Rana temporaria* (Linnaeus) tadpole. She states that, "Because the larvae had migrated prematurely, the bladder was undeveloped when they reached the cloacal chamber; presumably they could not have survived had metamorphosis not taken place soon afterwards." In the present case the single mature *P. nearcticum* was found attached in the anteriormost portion of the large intestine adjacent to the junction of the small intestine. It would appear, in this unusual case, that the physiological differences between the urinary bladder and the intestine do not serve as a strict "barrier" to prevent these worms from inhabiting the intestinal tract.

Bychowsky (12), Llewellyn (10), and Price (13) feel that endoparasitic tendencies as exemplified by some polystomes, like *P. nearcticum*, and certain other species of Monogenea are important evidence

in support of the evolution of cestodes from monogeneans.

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Chromatophore Thermoregulation in the Fiddler Crab, *Uca pugnax*

Abstract—Supporting evidence for the recently suggested thermoregulatory role of chromatophores is presented. Chromatophore index values and corresponding body temperatures of lighter (experimental) and darker (control) crabs indicate that lighter crabs maintain lower body temperatures when 1) ambient temperature remains fairly constant and 2) when ambient temperature is systematically increased to 40C.

Introduction

Although previous workers have studied the effects of environmental conditions on fiddler crab chromatophores, our understanding of the adaptive significance of diurnal coloration change in fiddler crabs remains incomplete. In an attempt to elucidate the phenomenon, Brown and Sandeen (1) studied the effects of background, light, and temperature on the black and white chromatophore systems responsible for coloration. Working with *Uca pugnator*, they found four types of chromatophore response: 1) endogenous rhythm (2); 2) albedo response (i.e., background response to the ratio of incident to reflected light in which black pigments disperse more on black background and white pigments disperse more on white); 3) response to total illumination (i.e., pigments disperse in direct proportion to light intensity); 4) response to temperature (i.e., all pigments concentrate within chromatophores at higher temperatures except white ones observed on black backgrounds).

All types of response function in each chromatophore system, amplifying and antagonizing each other to varying degrees and in different ways, to effect crab coloration under given conditions. One interesting interaction led Brown and Sandeen (1) to postulate a thermoregulatory role for chromatophores at higher temperatures. When crabs were observed in water bath pans painted black and heated (10–30C) for one hour by an incandescent light source, black pigment concentrated (15C) and white pigment dispersed (20C).

Wilkins and Fingerman (3) further investigated the thermoregulatory nature of chromatophores by

measuring reflectance capacities and body temperatures of crabs selected for their pale coloration (concentrated melanin) and dark coloration (dispersed melanin). Suspending the animals over the substratum for short time periods (15 minutes) in direct sunlight, they recorded body temperatures from pale and dark crabs. Light crabs maintained a body temperature 2C lower than dark crabs. To study the external effect of coloration, they measured the amount of light reflected from the cephalothorax of pale and dark crabs. Measurements showed that pale crabs do indeed reflect more light than dark crabs. Barnwell (4) further examined the relationship between body temperature and coloration in three other species of *Uca*. Using the water bath method (1), he exposed crabs to temperatures increasing at 5C per hour. His data are consistent with the hypothesis that blanching in these animals at higher temperatures has thermoregulatory significance.

Whether blanching has thermoregulatory significance at lower and fairly constant air temperatures has not been studied. Since eyestalk removal causes blanching (2, 5, 6), body temperatures can be recorded in the laboratory while melanin concentrates. The stronger tendency of black pigment to concentrate with increasing temperature (1) and the ease with which melanophores are observed offer a simple system of investigation. Experiments described below were designed to study the effect of blanching on body temperature when 1) ambient temperature remains fairly constant, and 2) ambient temperature is systematically increased.

Methods and Materials

The relationship between body temperature and coloration in *Uca pugnax* was established by simultaneously recording body temperatures and describing chromatophore state. Two Yellow Springs Instrument Co. hypodermic type thermoprobes (No. 514) and a YSI Telethermometer (Model 47) were used to record body temperatures, while the state of melanophores was estimated according to the Hogben and Slome (7) chromatophore index. A micro-thermoprobe served to record ambient temperature.

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Crabs were collected as needed during late spring from Indian Field Creek of the York River estuary. They were stored at 15°C in natural sea water which was changed every two days. No food was provided. Gravid females were not used. Data for each experiment were collected from control and experimental animals selected for similar size and sex.

Both eyestalks were removed from experimental crabs to effect color change from dark to light just before recording. Both control and experimental crabs were then securely fastened to a small plywood board covered by a paper towel moist with natural sea water. To minimize movement and insure stationary placement of thermocouples, elastic bands were stretched over the animals and anchored by small nails opposite one another in the wood. The apparatus was positioned under a microscope for chromatophore observation. Chromatophores on the inside of the third or fourth walking leg were used. Thermoprobe were inserted immediately proximal to the basi-ischiopodite of the last walking leg, and positioned well into the hemocoel. The micro-thermoprobe used to record ambient temperature was securely stationed between the two crabs. A 125-watt incandescent blue bulb was focused over the animals throughout the experiments.

Two sets of experimental conditions were used. In the first, the effect of destalking was studied under conditions of small ambient temperature fluctuations. For each of ten measurements, observations consisted of body temperatures, ambient temperature, and chromatophore indices recorded every ten minutes over a two hour period. In the second set of experiments, ambient temperature was systematically increased at the rate of 1°C per 4 minutes. An effective temperature gradient was established by constantly moving the incandescent bulb closer to the crabs. Observations again consisted of body temperatures, ambient temperature, and chromatophore indices recorded per degree rise in temperature over a period approximately one hour long, and between the recorded ambient temperatures

of 24°C and 40°C. Data were always collected in the afternoon between 12:00 and 6:00 PM.

Results

To reduce the number of simultaneous events in each set of experiments, body temperatures of control and experimental crabs were subtracted from their corresponding ambient temperature (A.T.). The mean control (\bar{X}_c) and experimental (\bar{X}_e) values were then calculated for $X = \text{chromatophore index}$ and $X = \text{body temperature}$. Values plotted represent the mean differences (\bar{d}) between mean control and experimental values ($\bar{X}_e - \bar{X}_c$). Actual \bar{d} values are given in Table I. Since ambient temperature was consistently higher than any recorded body temperature, a body temperature farther from ambient temperature (i.e., when either of the quantities (A.T. - \bar{X}_c) or (A.T. - \bar{X}_e) is numerically high) must be a lower body temperature. So, in Fig. 1 and 2, \bar{d} values plotted are positive when $\bar{X}_e > \bar{X}_c$ (i.e., the value \bar{X}_e represents the lower mean body temperature when $X = \text{body temperature}$), and negative when $\bar{X}_e < \bar{X}_c$ (i.e., the value \bar{X}_e represents the lower mean body temperature).

Fig. 1 illustrates the data collected from the first set of experiments where ambient temperature remained fairly constant. Because of the chromatophore index used⁽⁷⁾, in which high numbers indicate dispersed chromatophores (dark crabs) and low numbers the reverse, Fig. 1 demonstrates the expected result of destalking (2, 5, 6). Experimental crabs became progressively lighter than control crabs. Fig. 1 also shows that experimental crabs maintained a corresponding lower body temperature, despite no increase in external temperature. With respect to both parameters, control crabs changed in the opposite direction.

Fig. 2 illustrates the data collected from the second set of experiments where ambient temperature constantly increased. The curves plotted over this temperature gradient confirm the first set of results. Here, with a rise in temperature, experimental crabs became lighter and maintained a correspond-

TABLE I
Actual Values (\bar{d}) and Standard Deviations (sd) Plotted in Fig. 1 and 2.

Time	Chromatophore Index	Body Temperature		Temperature	Chromatophore Index	Body Temperature			
min	\bar{d}	sd	\bar{d}	sd	°C	\bar{d}	sd	\bar{d}	sd
0	-0.75	0.37	+0.08	0.26	24	-0.142	0.44	+0.1	0.11
10	-0.75	0.37	+0.0625	0.39	25	-0.055	0.37	+0.0333	0.16
20	-0.45	0.43	-0.11	0.21	26	-0.4	0.51	-0.01	0.21
30	+0.13	0.40	+3.25	0.35	27	-0.2	0.48	-0.28	0.15
40	+0.18	0.39	-0.17	0.13	28	-0.2	0.48	-0.30	0.10
50	+0.45	0.47	-0.05	0.18	29	+0.15	0.46	-0.48	0.15
60	+0.65	0.51	-0.11	0.17	30	+0.2	0.33	-0.63	0.16
70	+0.80	0.53	-0.09	0.18	31	+0.5	0.23	-0.7888	0.11
80	+0.95	0.52	+0.03	0.20	32	+0.666	0.40	-0.8444	0.09
90	+1.28	0.53	+0.04	0.23	33	+0.65	0.35	-1.06	0.11
100	+1.58	0.50	+0.05	0.23	34	+0.722	0.33	-1.1777	0.13
110	+1.73	0.47	-0.05	0.21	35	+0.55	0.33	-1.29	0.13
120	+1.73	0.47	-0.02	0.26	36	+0.944	0.25	-1.2555	0.18
					37	+0.937	0.30	-1.7375	0.31
					38	+0.833	0.33	-1.7222	0.23
					39	+0.65	0.39	-1.76	0.37
					40	+0.9	0.24	-1.52	0.37

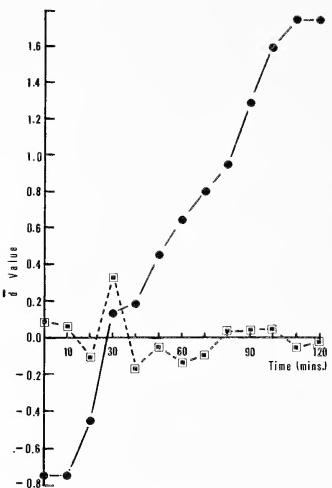


FIG. 1—Change in chromatophore index (solid line) and body temperature (dashed line) as the difference (\bar{d}) between mean control (\bar{X}_c) and mean experimental (\bar{X}_e) values over a two hour period.

ing lower body temperature at the endpoint (40°C). Control crabs changed from precisely that condition at the beginning temperature (24°C) to one exactly opposite.

Conclusion

The first set of experiments tests the direct effect of blanching on body temperature. Final paling in experimental crabs (the expected result of destalking) was accompanied by a lower body temperature than was recorded in darker control animals. This inverse relationship between chromatophore index and body temperature supports the findings of Wilkens and Fingerman (3) and Barnwell (4). It indicates some ability on the part of chromatophores to modify body temperature.

Under conditions of changing ambient temperature, destalked crabs paled and, at the arbitrary endpoint of 40°C, maintained a lower body temperature than control crabs. Control crabs, on the other hand, were darker and maintained a higher body temperature. But they had paled somewhat from their dark coloration at 24°C, at which point they maintained a corresponding higher body temperature.

Since it took approximately an hour to reach the endpoint (40°C), experimental crabs blanched faster as well as more than control animals and all crabs previously used. This shortened period of melanin concentration may have been due to the additional effect of heat on the chromatophores. Such a direct effect of heat would explain the lesser blanching in control crabs, where heat effects had to

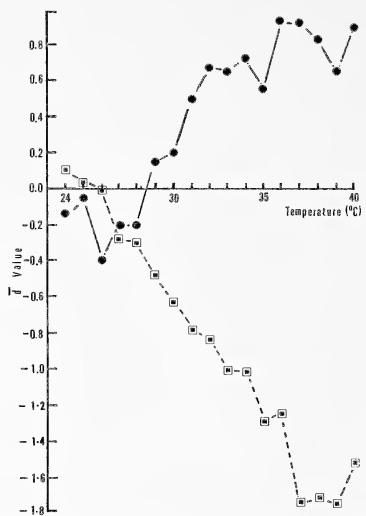


FIG. 2—Change in chromatophore index (solid line) and body temperature (dashed line) as a function of rising ambient temperature. Each point represents 7–10 measurements.

overcome those of illumination¹ and diurnal rhythm. This supports Brown and Sandeen's (1) suggestion that temperature may be the strongest factor influencing crab coloration under certain conditions.

But the import of such a temperature effect is plagued with question marks. No satisfactory adaptive explanation has been established for the baffling effects of diurnal rhythm which oppose the response to high temperature in the field. The crabs paradoxically flaunt their dark colors during the peak of noon heat. Behavioral adaptations have been suggested (3, 4) to resolve the dilemma. Protective coloration is a more obvious plea favoring its maintenance. Speculations based on the data presented here and in previously cited papers may elucidate the phenomenon.

If Brown and Sandeen (1) are correct, crabs in the field are exposed to three melanin dispersing factors; increasing light intensity, dark background, and diurnal rhythm. When high temperatures threaten these intertidal animals, blanching may result from a direct effect of heat on chromatophores. By lowering body temperature, such blanching could raise lethal levels, conserve moisture, extend exposure time for feeding and display. The terrestrial range of these animals might be extended as a result. The mechanism could also offer immediate protection in case of eyestalk injury, where fast

¹ Brown and Sandeen (1) make no statement on the mechanism of chromatophore response to light intensity. Hence a direct effect of illumination on chromatophores may occur. If so, I am assuming it will be secondary to the response evoked by light reception through the eyes.

blanching would minimize an animal's sensitivity to environmental stress until recovery.

The independent melanophore response to heat effects affords built-in protection under extreme conditions. How these conditions affect crab coloration has been studied. But further study is needed in the field to demonstrate conclusively the validity of the hypotheses presented.

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Gonadotropins and Testes Response of Lines of Chickens Differing in Age at Sexual Maturity

Abstract—Testes weight responses to ovine FSH and chicken pituitary homogenates were measured in lines of chickens known to differ in age at sexual maturity. Significant linear, quadratic, and cubic effects were consistently noted in response to FSH dosages ranging from 0 to 625 µg. The curvilinear response was consistent in both lines and when FSH was administered either alone, or in combination with LtH or stilbestrol. Response to pituitary homogenates was also curvilinear. The threshold of response in the early maturing line was significantly lower than that for the late maturing line.

Introduction

Genetic variation in the chick testes weight response to gonadotropins is well documented. White Rock males are more responsive to gonadotropins than males of other breeds (1, 2). Differences among families of paternal half-sibs were demonstrated for preparations of avian pituitary homogenates, pregnant mare serum, follicle stimulating hormone, and luteinizing hormone (3).

Reproductive responses associated with selection for body weight in chickens are well known (4, 5, 6). We have selected for high (HW) and low (LW) body weight at eight weeks of age (7) and observed that males and females in the HW line matured earlier than those in the LW line (8, 9). During the natural sexual maturation process the pituitary gonadotropin concentration was comparable in both lines on a per unit weight basis, but that there was a greater pituitary mass in the HW than in the LW line (10). Also noted (11) were possible differences in gonadal tissue sensitivities between these lines when the hypothalamic-hypophyseal axis was forcefully stimulated by administration of the drug MER-25 (ethamoxytriphetol).

The experiments reported here were conducted to study further the effects of gonadotropins in the HW and LW lines as an aid to explaining the difference in age at sexual maturity. Since large doses of gonadotropins were given, data were also obtained on the linearity and curvilinearity of the response.

Methods and Materials

Response to gonadotropin treatments (Table I) was measured by testes weights of chicks from F_{10} generation matings of the HW and LW lines.

The assay procedure was similar to that of Breneman, *et al.* (12). Gonadotropin was dissolved in 0.85% saline and three 0.2 ml injections were administered subcutaneously in the dorsal neck region of day-old cockerels. Injections were made at 12-hour intervals. Commencing 12 hours after the third injection, chicks were randomized, weighed and the testes removed and weighed to the nearest 0.1 mg. The same procedure was used for saline-injected controls. During the period from hatching to final randomization chicks were kept in a dark hatcher without feed and water. Chicks in this environment remain in a vigorous condition.

Analysis of gland and organ data has been discussed by several investigators (13, 14, 15). Although difficulty may arise when there is a wide range in body weights, this is reduced with young chicks because body weight at hatching is largely determined by egg weight (16, 17). Testes weights were analyzed on an unadjusted basis. When there was a significant regression of testes weight on body weight, analysis was also by covariance and by adjusting to 100 g body weight. In addition the testes weight response on gonadotropin dosage was evaluated for curvilinearity by fitting polynomial equations.

Four experiments were conducted, with treatments and numbers of chicks summarized in Table I. The testes weight response of HW and LW cockerels to various levels of follicle stimulating hormone (FSH) was measured in Experiment 1. In Experiment 2 FSH alone and in combination with luteotropic hormone (LtH) were administered to LW cockerels only and the testes weight response measured. Experiment 3 involved the testes weight response in both lines to FSH alone and to FSH in combination with stilbestrol. Pituitary homogenates were administered in Experiment 4 to HW and LW males and the testes weight response measured. The pituitaries, obtained from commercial broilers, were acetone-dried, and then homogenized and suspended in saline just prior to starting the experiment.

Results and Discussion

Experiment 1. There was a significant regression of testes weight on body weight. Thus, testes weights

were analyzed on an unadjusted basis and adjusted both to a constant body weight and per 100 g of body weight. Differences between lines for testes weight response to graded levels of ovine FSH were not significant. Mean testes weights were 6.34 mg for HW and 5.87 mg for LW males on an unadjusted basis, 21.7 mg for HW and 21.7 mg for LW males expressed per 100 g body weight, and 6.14 mg for HW and 6.07 mg for LW males by covariance. The line-hormone level interaction was not significant in any of the three analyses indicating that both lines responded in a comparable manner to the dosages of FSH used here.

Differences among FSH dosages were highly significant (Table II). Comparable results were obtained for adjusted and unadjusted data indicating that the gland-body weight relationship was not of sufficient magnitude to alter the results. Comparisons of means show that testes weights at the 25 µg level of FSH were significantly greater than the saline controls. Testes weights increased with dosage peaking at the 250 µg level which, in turn, was significantly greater than the 375 and 625 µg levels. Linear, quadratic and cubic effects were highly significant. Transformation to logarithms does not resolve the curvilinearity. Although a linear effect is expected, and the quadratic effect may be explained biologically by the classic stimulatory-inhibitory type of response, a logical explanation for the cubic effect was not apparent to us. Accordingly, Experiment 2 was conducted.

Experiment 2. Injections of LtH may cause testicular regression in some species of birds (18, 19). We hypothesized that an interplay of FSH and LtH, if the former were contaminated by the latter, could, particularly at the higher levels of FSH, cause the curvilinear effects noted in the first experiment. Accordingly, FSH was injected without and in combination with LtH into LW line males. There was no significant regression of testes weight on body

TABLE II

Means and Standard Errors of Testes Weights of Chicks Receiving Various Levels of FSH, Expt. I

µg FSH	Testes wt ¹		
	Unadjusted	per 100 g body wt.	Covar. to grand mean
0	3.26 ± .29 ^a	12.4 ^a	3.60 ^a
5	4.02 ± .49 ^{ab}	14.7 ^{ab}	4.21 ^{ab}
25	5.21 ± .41 ^b	19.1 ^{bc}	5.33 ^{bc}
75	6.78 ± .63 ^c	23.8 ^{ed}	6.68 ^c
125	6.84 ± .59 ^c	24.1 ^{ed}	6.74 ^c
250	9.29 ± .82 ^d	32.6 ^e	9.05 ^d
375	6.49 ± .70 ^e	21.9 ^{ed}	6.24 ^e
625	6.91 ± .72 ^e	25.2 ^d	6.99 ^e

¹ Lines were pooled because there was no significant difference between them.

Any two means in a column that do not have the same superscript are significantly different ($P \leq .05$).

weight, hence data were not adjusted. Mean testes weights were 8.55 and 8.22 mg at the 0 and 8 IU. levels of LtH, respectively. This difference was not significant. The LtH-FSH interaction also was not significant indicating that the response to FSH was comparable with or without administration of LtH.

The response of FSH (Table III) was comparable to that observed in Experiment 1, with the peak response at the 250 µg level. Again the quadratic and cubic effects were significant, demonstrating a curvilinear response of testes weight to FSH.

Experiment 3. The chick hypophysis has the capability to secrete gonadotropins prior to hatching (20, 21). Although hypophyseal secretion should be minimal during the brief injection period of our experiments, such an early function might explain the curvilinear response. This curvilinearity could be a synergistic action of exogenous and endogenous gonadotropins at low dosages of FSH, followed by a decreased endogenous gonadotropin secretion at intermediate exogenous levels, and a secondary increase of testes weights at the higher exogenous FSH levels that was independent of or overcame the diminishing endogenous aspects. This may be investigated by utilizing hypophysectomized chicks. "Physiological hypophysectomy" may be achieved by implants of estrogen (22). This procedure was followed in Experiment 3 by administration of stilbestrol (Table IV).

There was no evidence of a regression of testes weight on body weight in this experiment which was consistent with that found in Experiment 2. A comparison of testes weights of chicks receiving 0 and 0.1 mg of stilbestrol showed no significant effect of stilbestrol on testes weight in either the HW and LW lines. Thus, all subsequent comparisons are for the 0.1 mg level of stilbestrol.

Mean unadjusted testes weights were 6.7 mg for the HW line and 6.0 mg for the LW line. The difference of 0.7 mg approached significance at the 5% level. The line-FSH level interaction also was not significant indicating that both lines responded

TABLE I

Numbers of Chicks per Treatment and Line by Experiment

FSH ¹ µg	Expt 1						Expt 2 ²			Expt 3 ³			Expt 4		
	Line ²			I.U. LtH ⁴			Line			Line			PiL ⁵		
	HW	LW	0	8	HW	LW	mg	HW	LW	mg	HW	LW	mg	HW	LW
0	8	8	9	9	9	11		0	9	9					
5	8	8			9	11		.1	9	9					
25	8	8	9	9	9	11		.3	9	9					
75	8	8			9	11		.6	9	9					
125	8	8	9	9	9	11		1.0	9	9					
250	8	8	9	9	9	11		2.0	9	9					
375	8	8	9	9	9	11									
625	8	8	9	9	9	11									
Total	64	64	54	54	72	88					54	54			

¹ NIH-FSH-S4 ovine used in Expt. 1, 2 and 3.

² LW-low weight line, HW-high weight line.

³ All LW hosts.

⁴ NIH-LtH-P-S8 Ovine.

⁵ All received 0.1 mg stilbestrol.

⁶ Chicken pituitary on a dry weight basis.

TABLE III

Means and Standard Errors of Testes Weights of Chicks Receiving Various Levels of FSH, Expt. 2

μg FSH	Testes wt ¹
0	5.56 ± .43 ^a
25	5.68 ± .23 ^a
125	9.86 ± .77 ^b
250	10.04 ± .60 ^b
375	9.62 ± .74 ^b
625	9.41 ± .73 ^b

¹ The 0 and 8 I.U. levels of LtH were pooled because there was no significant difference between them.

Any two means in a column that do not have the same superscript are significantly different ($P \leq .05$).

in a comparable manner. Again there was a significant curvilinear response to FSH dosages. Although the peak was at 375 μg of FSH rather than at 250 μg as in Experiments 1 and 2, the difference between 250 and 375 μg levels was not significant.

These experiments have consistently demonstrated a curvilinear response of chick testes weights to injections ranging from 0 to 625 μg of ovine FSH. The response does not appear to be specific for a particular population because it was obtained in two lines that are known to differ in a large number of morphological and physiological traits. One of the purposes of this study was to compare these lines, known to differ in age at sexual maturity, for their response to FSH. None was found in Experiments 1, 2 and 3 when mammalian gonadotropin was used. Since it is well established that birds are more sensitive to avian gonadotropins than to mammalian gonadotropins (23, 24), avian pituitary homogenates were used in an effort to evaluate the existence of a gonadal sensitivity differential. These results are presented in Experiment 4.

Experiment 4. There was no significant regression of testes weight on body weight, a result consistent with that found in Experiments 2 and 3. Mean testes weights were 8.9 mg for the HW line and 7.4 mg for the LW line with the difference being highly significant. Evidence of the greater target organ response in HW than in LW chicks may be seen in

TABLE IV

Means and Standard Errors of Testes Weights of Chicks Receiving 0.1 mg Stilbestrol and Various Levels of FSH, Expt. 3

g FSH	Testes wt ¹
0	4.56 ± .44 ^a
5	4.24 ± .39 ^a
25	5.60 ± .45 ^{ab}
75	6.83 ± .43 ^{bc}
125	7.24 ± .58 ^{cd}
250	7.12 ± .46 ^d
375	8.37 ± .62 ^d
625	6.41 ± .64 ^{bc}

¹ Lines were pooled because there was no significant differences between them.

Any two means in a column that do not have the same superscript are significantly different ($P \leq .05$).

TABLE V

Means and Standard Errors of Testes Weights of HW and LW Chicks Receiving Various Levels of Pituitary, Expt. 4

Testes wt			
mg Pit.	HW	LW	Pooled
0	5.92	5.27	5.58 ± .37 ^a
0.1	8.10	7.34	7.72 ± .69 ^b
0.3	8.59	6.70	7.64 ± .48 ^b
0.6	10.88	8.34	9.61 ± .88 ^b
1.0	9.74	7.80	8.77 ± .70 ^b
2.0	10.09	8.84	9.46 ± .65 ^b

Any two means in the pooled column that do not have the same superscript are significantly different ($P \leq .05$).

Table V. At all levels the mean for the HW line was greater than that for the LW line and demonstrates the lack of a significant line-pituitary interaction. In an earlier experiment (10) there was no difference between lines to injections of 0.2 mg of pituitary. Host chicks were from earlier generations (F_5 and F_9 combined) and hence there had been less selection. The data obtained in the present experiment suggest a lower threshold for response to gonadotropins in the HW line than in the LW line. This lower threshold of the target organ, plus the greater pituitary mass in the HW line (10), may partially explain why this line reaches sexual maturity at an earlier chronological age than the LW line.

Polynomial equations for testes weight response on pituitary dosages reveal significant linear, quadratic and cubic effects. The peak levels were comparable to those obtained from ovine FSH which also yielded a cubic response. Responses beyond the first and second degree are seldom reported in experiments of this type. We are unaware whether the curvilinear results from this series of experiments are unique or if they have been ignored because biological explanations for them are not readily apparent.

Acknowledgments

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Man and Energy

Every living organism is dependent upon energy for its existence, and man is no exception. Man is exceptional, however, in that he alone has been able by "scientific research" to investigate energy processes, like fire, falling water, and the sun, and to understand how they work. By "technological innovation" man has simulated some of these natural processes so that he can produce energy at will to serve his needs. It is this control of energy which provides the base upon which civilizations are built and to a large extent determines the character of life within them. Because of the fundamental importance of energy processes to all aspects of life, both natural and civilized, we attempt here to categorize and describe how each works.

Before beginning this codification, we introduce two basic ideas which bear on the subject. The first has roots in a pair of clichés many of us were required to memorize during a grade school indoctrination in physical science, where it was announced that "Matter can neither be created nor destroyed," and that likewise "Energy can neither be created nor destroyed." Each of these statements alone is false. Early in this century Einstein speculated that it was perfectly acceptable in Nature to have matter destroyed. In fact, whenever this occurs a certain amount of energy appears in its place. Furthermore energy can be materialized. The expression which defines these conversions is the familiar $E = mc^2$, where the rate-of-exchange, c^2 , is the square of the velocity of light in a vacuum. This relationship agrees with experimental observations and implies that matter is just another state of energy, as ice is another state of water. The conservation statement is then "Mass-energy can neither be created nor destroyed but can change its form."

The second preliminary point is that whenever energy is derived from a material the old structure is destroyed and is replaced by new ones. When you light a fire because you wish to obtain its warmth (i.e. energy) in the process of burning (deriving energy), the structure of the wood is destroyed, and the structures ashes, smoke, soot, and various gases and vapors are created. We note a sociological parallel to this process. When a civilization finds a new way to produce energy, its structure is de-

stroyed, and a society based on a new structure is created in its place. This phenomenon is so apparent that the history of man can be described in terms of a series of revolutions, each of which was ushered in when a new means of producing controlled energy was developed.

Now back to the subject at hand: energy. When material bodies communicate and influence each other's behavior, we say they "interact." Physicists believe that there are only four interactions: the gravitational, the weak, the electromagnetic, and the strong. Each structure in the universe is a result of one of these interactions. In order to quantitatively describe how one body interacts with another, we examine the "force" one exerts on the other by means of a given interaction. If a body which is free to move feels a force, it will experience a change in its velocity and location. The energy which a body acquires as a result of an interaction is equal to the strength of the force along the line on which it is acting times the distance the body moves while the force is applied.

For our purposes it is convenient to divide energy into two types, latent and active. The principle of conservation of mass-energy, discussed above, may be restated as follows: the total energy of a system (latent plus active) will remain constant regardless of how drastically the elements of that system are rearranged. Furthermore, the material objects which constitute the system, if given the opportunity, prefer to deploy themselves so that they possess the least possible amount of latent energy. The unignited match, the ball precipitously perched on the edge of a cliff, the uranium nucleus prior to its division, and the mass a particle possesses are all examples of latent energy. Latent energy is that energy which could be released by a system should the opportunity to do so present itself. The second type of energy is that possessed by a body due to its action. The baseball sailing towards the center field wall, the Ferris wheel making its monotonous turns, the termite in the process of dismantling a tree stump, and the wave wiping out a surfer on his run for the beach are all examples of active energy. Let us examine the sources of energy which man has available to him as a result of each of the four interactions in Nature.

The gravitational interaction is well known from the legend, however apocryphal, about the apple and Mr. Newton. The apple's latent energy, which was due to its separation from the earth while under the influence of the mutual gravitational attraction of the earth and apple, was converted to active energy when the latter fell from the tree. When the apple was stopped by Mr. Newton's head the active energy was expended in rearranging some material in both apple and head in structures called bruises. The final result of the fall was to leave tree-apple-Newton-earth system closer to one another (i.e. more tightly bound). Note that to return to the original state of the system we would have to pick up the apple, climb a ladder and tie it back on the tree. This is the reversible part of the process. We would also have to move all the molecules in the bruises back into their pre-collision positions. This is the irreversible part.

The idea of converting energy from latent to active by letting objects fall under the influence of gravity has useful applications. Instead of apples, today we go into the mountains and dam up rivers running swiftly in their steep gorges. We let some of the water fall in vertical pipes from the top of the reservoir to the ground below. Very near the bottom of the pipe there is a paddle wheel. The water with its latent energy at the top of the dam now converted to active energy roars past the blades of the wheel turning it and transferring energy to its shaft. The turning shaft then generates electricity, hydroelectricity.

A second and more direct example of the gravitational interaction generating the energy used to run a machine is the grandfather clock. This device is powered by a long chain with a weight on its end which hangs over a spoked wheel. When the tension on the shaft to the wheel is insufficient to hold up the weight, the weight falls a notch or two turning the wheel in the process. This assures that the clock continues to function. The weight, under the gravitational interaction, converts latent energy due to its position in the gravitational field of the earth into active energy which is used to drive a mechanical device.

The generation of electricity, alluded to previously, is the most obvious energy consequence of the electromagnetic interaction. Note that rubbing a metal rod with animal fur transfers some electrons from the atoms of the fur onto the rod. Active energy (rubbing) is stored as latent energy (separate electric charges) which is converted into active energy (a spark) when the objects are brought in close proximity to one another. The electric generator, a slightly more sophisticated device built in a circular manner, achieves the same end but more efficiently. If electricity is used to drive a similar circular device in order to produce mechanical energy, it is called a motor.

The incandescent light utilizes electromagnetic energy in a different manner. The ease with which electrons circulate in material under the influence of an electric field is described by the conductivity of that material, and is dependent on its atomic

and molecular structure. Regardless of how unobstructed the electron's path is, by moving in matter, electrons will lose some energy which the conducting material gains. This results in the heating up of the material, sometimes so hot that it glows visibly.

Next we turn our attention to the systems which owe their existence and structure to the electromagnetic interaction. This interaction binds negatively charged electrons to the positively charged nucleus. The fact that the electrons retain a certain distance from the nucleus despite the presence of an attractive force is due to a set of rules of microscopic social behavior, which are set forth under the title of quantum mechanics. Nonetheless, the electrons within the allowed states arrange themselves so as to minimize the energy of the atom. Turning to slightly more complicated systems, we note that atoms can combine into a conglomerate system, called a molecule, if it is energetically advantageous to do so. This binding of essentially electrically neutral objects is effected by the electromagnetic interaction, for when atoms are brought in close proximity their electron clouds are distorted individualistically so as to produce local regions with non-zero electric fields which allow binding. Structures made up of molecules (e.g. cells, crystals) are formed in a similar manner.

It is possible to put in two separated portions of a can two materials, one which gives up its electrons fairly easily and the other which likes to absorb electrons. Energy is derived from this device, a battery, when, for instance, a transistor radio is hooked between its two sources. The differences in electron affinity and thus the differences in chemical reactivity of the stored materials, derive from the differences in chemical structure of the ingredients. These differences are dictated by the electromagnetic interaction. The source of the energy here is something different from what we have studied previously because no mechanical means was used to separate the electrons from the atoms. Here two chemical materials would be in a lower energy state (more tightly bound) if they were combined with a different number of electrons than those which originally made each of them neutral. This kind of process also occurs as a material changes its chemical composition when burning; it rearranges itself into structures which have less energy. For most materials this burning process does not occur spontaneously and must be aided by applying some energy (heat) to start the reaction. The end results are, of course, the production of energy (heat) and more tightly bound chemical systems.

Let us consider now an energy storage device which appears to be mechanical but is really a consequence of the electromagnetic interaction. This is the simple spring. When it is stretched (or compressed) it tends to return to its original length, thus releasing the energy stored in it by the pull (or push). The force causing this restoration is just the sum of those forces acting among the molecules of the spring material due to their initial relative positions. Displacing the molecules from their normal positions results in a less tightly bound system,

so when free to move the molecules will relax the strain by returning to their original positions. In the process the spring will return to its unstressed shape.

The next energy source is stereotyped by the mushroom-shaped cloud which ensued when it was first used for the purpose of political intimidation. The process is called fission and celebrates an occasion when the electromagnetic interaction triumphs over another interaction: the strong interaction. This latter interaction is so named because it overcomes the electromagnetic interaction at very small distances in order for the nucleus to exist. Its success is seen by the fact that many particles of the same (positive) charge can usually cohabit in a small volume of the nucleus without exploding. However, occasionally when the nucleus gets too big and sloppy (i.e. unspherical) the individual nucleons slosh around, deforming the imaginary membrane formed by the strong interaction. If this sack of nucleons should happen to find itself distorted into a dumbbell or Indian club shape, it then becomes energetically advantageous for the nucleus to separate into two parts (i.e. fission). The two resulting nuclei realize very quickly that they each have too many neutrons for their size and proceed to eject neutrons until they reach an allowable neutron and proton population. Then the weak interaction transmutes each nucleus into a stable variety by successive electron emissions.

This process just described provides the basis for the device which will effect our next energy revolution: the nuclear reactor. Here atoms of Uranium 235 or Plutonium 239 are allowed to fission under controlled conditions, and the energy from the reaction and the subsequent nuclear transformations is converted into heat which can be used in a conventional manner. Unfortunately, the naturally occurring fissile materials are not abundant in Nature. The practical difficulties in realizing this process account for the limits in operating with nuclear power today. The revolution is imminent, however, because reactors which will produce more fissile material than they use and at the same time provide energy are proving practical. These reactors, called breeders, use those many neutrons made homeless immediately after fission to impregnate the abundantly available and benign Uranium 238 nuclei. The Uranium 239 which is formed, then decays by means of the weak interaction emitting an electron. The resulting nucleus, Plutonium 239, can fission.

An energy process which is motivated solely by the strong interaction, of which we see a shining example every day in our sun, is fusion. Fusion is dependent on the fact that nucleons like to live together in the form of a nucleus rather than by themselves. The simplest of nucleon systems is the deuteron—a neutron and proton bound together. Like any two individuals the neutron-proton system gave up something in order to be united—in this case—energy: 2,224,000 electron volts (eV) in fact. Now if two of these deuterons got close enough to overcome the electromagnetic repulsion of their respective positive charges they could form a helium nucleus—alpha particle—and release about twenty-

five million electron volts of energy! This process of fusing nucleons together forming more and more tightly bound systems, releasing energy each time, takes place easily in every star (sun) in the universe. Serious, but to date unsuccessful, attempts have been made to reproduce this process in a controlled way here on earth. The difficulty, of course, is how to get a swarm of nucleons going fast enough so that they have sufficient energy to approach near enough to one another to fuse. This plasma of particles must simultaneously be confined to a small enough volume so that there will be a reasonable chance for one particle to encounter another and thus effect a mating.

Another conceivable type of energy generation will probably never be available on this planet. It may, however, be occurring deep in space and making itself known through small but very intense light sources called quasars. This process may be the result of matter encountering antimatter. Such annihilation has been studied since the positron (anti-electron) was discovered over thirty years ago. When a positron comes to rest in the vicinity of an electron the electromagnetic force brings the two of them together causing them to simultaneously spiral towards one another, losing energy by emitting soft photons (light) as they do so. Shortly after the minimum encounter distance is achieved—poof—no more particles, just two photons of energy of a half a million electron volts, each screaming off in opposite directions. For a proton-antiproton annihilation the script is similar except that the intermediate debris is more varied, the degradation process is more complex, and the consequence is a number of photons and neutrinos (massless, almost undetectable particles which travel at the speed of light). The whole mess has the equivalent energy of the original proton and antiproton masses. The reason that terrestrial confinement of this reaction as a usable energy source is improbable arises from the fact that no appreciable supply of antimatter is known to exist in the region of space inhabited by our galaxy. Even if there were such a supply, because of the extreme reactivity of antimatter when brought into contact with matter, the problem of controlling its reaction would be immense indeed.

Table I summarizes the percentage of energy that is produced in relation to the participating mass of the system for each of the processes discussed. This

TABLE I.
Efficiency for Various Energy Producing Processes Available to Man.

Interaction	Energy Release for Typical Atomic or Nuclear Systems	Efficiency
Gravitational	$\sim 10^{-40}$ eV	$\sim 0\%$
Electromagnetic		
Chemical Reaction	$\sim 1-5$ eV	$\sim 2 \times 10^{-7}\%$
Fission	$\sim 2 \times 10^8$ eV	$\sim 0.1\%$
Strong		
Fusion	$\sim 3 \times 10^7$ eV	$\sim 0.6\%$
Matter-Antimatter	$\sim 2 \times 10^9$ eV	$\sim 100\%$

in a way assigns an "efficiency" to each energy production process. It should be noted that of these discoveries which have and will change the character of civilized life, each has had its roots in man's deep desire to understand the functioning of the world in which he lives.

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CONFLICT

The National Science Teachers Association will hold its 1970 Eastern Regional Conference at the Shelburne Hotel in Atlantic City, New Jersey May 7-9, 1970. The theme of the conference is "Society and Survival, A Challenge For Science."

It is regrettable that the conference conflicts with the Annual Meeting of the Virginia Academy of Science in Richmond, May 5-8, 1970.

Communications and Reports

Notes on the Fishes Collected at McMurdo Sound, Antarctica, During the Austral Summer of 1964-65, with Information on the Diets of Two Species

In the course of a survey (supported by GA 146, United States Antarctic Research Program, National Science Foundation) of intestinal helminths of coastal fishes the following piscine species were collected. (Asterisks following names indicate that representatives were submitted for confirmation of identification to Hugh H. DeWitt, University of Southern California, whose assistance is gratefully acknowledged. Number of each piscine species collected is indicated in parentheses): *Nototheniidae*; *Trematomus bernacchii** (98), *Trematomus borchgrevinki** (55), *Trematomus hansonii** (27), *Trematomus loennbergii** (1), *Pleuragramma antarcticum** (4), *Dissostichus mawsoni* (3, only one with intestinal tract); *Chaenichthyidae*; unidentified further (1); and *Zoarcidae*; *Rhigophila dearborni** (80). Fishes were collected using traps or hook and line, were retrieved from seals, and were recovered from the stomach of a predatory fish. The fishes were collected near McMurdo Base ($77^{\circ} 51' S$; $166^{\circ} 40' E$).

Four identifiable *Pantarcicum* were recovered from the stomach of one *D. mawsoni* which was thrown up on the sea ice by a Weddell seal. This find confirms the predacious character of *D. mawsoni*, and records *P. antarcticum* as a dietary component of *D. mawsoni* as well as seals and whales (1).

The stomach contents of 39 *Rhigophila dearborni* collected with traps were analyzed and the following amphipods identified: *Orchomenella plebs* in 36 (92%), *Orchomenella rossi* in 6 (15%), and both species of *Orchomenella* in 3 (8%). The author is indebted to D. E. Hurley, New Zealand Oceanographic Institute, Wellington, for identification of the amphipods. *R. dearborni* were collected in traps baited with seal meat which appears to attract large numbers of amphipods which in turn attract fishes. Thus the stomach analyses may not reflect natural proportions of dietary components. It is interesting that the proportions of the two amphipod species in the stomach contents of *R. dearborni* agree rather closely with the relative frequencies of these two species in collections from the Ross Sea (2).

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The Insects of Virginia

A new series of bulletins with this title has been initiated by Michael Kosztarab of the Department of Entomology, Virginia Polytechnic Institute, Blacksburg, Virginia. The objective is to provide a systematic treatment including records on biology and ecology of the different insect orders and families in Virginia. The general policy for the series is described in the introductory article of the first bulletin. Only the results of unpublished, original research dealing with insects in Virginia can be printed in this series. The Board of Review includes James McD. Grayson, Richard L. Hoffman, and Michael Kosztarab. Manuscripts should be submitted to Dr. Grayson. One hundred reprints of bulletins are offered free to authors. Publisher is the Research Division, Virginia Polytechnic Institute.

The bulletins are printed with a yellow cover in a uniform style and size so that several may be bound together in a book form. The tiger swallowtail butterfly, the first insect to be described from North America, collected in "Virginia," symbolizes the series and appears on the cover of each bulletin.

The first issue (September 1969) includes two titles: I—Introduction to the series of bulletins on the insects of Virginia, with a literature review, by Michael Kosztarab; II—The biotic regions of Virginia, by Richard L. Hoffman. The second issue (October 1969) was written on the "Mosquitoes of Virginia" by William J. Gladney and E. Craig Turner, Jr. This latter article deals primarily with the distribution and bionomics of each species in Virginia, since excellent references are available on their taxonomic treatment.

Both bulletins will be sent free on request from the Publication Office, 405 Hutcheson Hall, Virginia Polytechnic Institute, Blacksburg, Virginia 24061. Exchanges are encouraged.

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News and Notes

FROM THE PRESIDENT'S OFFICE

The Academy, as you know, is a statewide interdisciplinary association of over 1800 scientists with the primary objective of advancing scientific endeavor in Virginia. We are affiliated with the AAAS and are represented on the Council of that group.

Actually the Academy is composed of the 13 discipline sections. It provides a forum where research experiences can be shared and where weakness in facilities and opportunities for science and education in Virginia can be aired. The Academy in addition to publishing the *Virginia Journal of Science* sponsors symposia on current problems, and publications of state and regional importance.

The youth program is, in my opinion, one of the outstanding activities of the Academy. The Visiting Scientist Program enables scientists to visit secondary schools and contribute to the education of our youth. The Science Talent Search has enabled outstanding youngsters to qualify for thousands of dollars of College scholarships. The Virginia Junior Academy of Science is recognized as one of the outstanding Junior Academies in the nation. During the past academic year approximately 5000 high school students participated in this growing program.

The youth programs have been partially supported by grants from the National Science Foundation. Recently such support has been curtailed because of cutbacks in the federal budget. The maintaining and further development of these activities requires additional revenues. I urgently ask you to consider becoming either a contributing or sustaining member of the Academy.

D. RAE CARPENTER, JR.

VIMS SCIENCE BUILDING DEDICATED

Richard Evelyn Byrd Hall was dedicated at the Virginia Institute of Marine Science at Gloucester Point on October 4, 1969. Governor Mills E. Godwin, Jr., gave the dedication address and Senator Harry F. Byrd, Jr., spoke on behalf of the Byrd Family. Other members of the Byrd family at the ceremonies included the Admiral's three daughters, Mrs. William Clarke and Mrs. L. J. Stabler, Jr., of Philadelphia, and Mrs. Robert Brayer of Los Angeles. Rear Admiral George J. Dufek, USN (Ret.), Director of the Mariner's Museum in Newport News, spoke on the personal and professional life of Richard Evelyn Byrd. The destroyer, USS Richard E. Byrd (DDG-23) was anchored offshore, and its commanding officer, Commander David E. Oaksmith, Jr., USN, presented the ship's plaque and national ensign to the Virginia Institute of Marine Science. Dr. William J. Hargis, Jr., Director of VIMS, spoke in appreciation of the new facilities, and with Governor Godwin presented engraved bowls to past members of the Board of Administration in recognition of their service to the Virginia Institute of Marine Science. The Navy's Atlantic Fleet Band played. Ap-

proximately 600 people attended and toured the facilities of the Virginia Institute of Marine Science and the destroyer Richard E. Byrd.

Richard Evelyn Byrd Hall contains some 21,000 square feet of working area and virtually doubles the institute's floor space. The three-story building was built entirely with state funds and houses the Department of Ecology and Pollution, Applied Science, Data Processing, Physiology, Jellyfish Investigation and laboratories for chemical oceanography, offices, class rooms and seminar facilities. Construction funds were appropriated by the 1966 General Assembly and approved by Governor Mills E. Godwin, Jr. The building was designed by architect Robert J. Leary, AIA, of Richmond.

LONGWOOD COLLEGE APPOINTS CHAIRMAN

Dr. Marvin W. Scott has been appointed chairman of the department of natural sciences at Longwood College, after having served as acting chairman since February. He succeeds Dr. Robert T. Brumfield who resigned after eight years as department head in order to devote full time to teaching and research in which he was engaged prior to becoming chairman.

A 1959 graduate of Hampden-Sydney College where he taught biology for one year, the 33-year-old scientist went to Longwood in 1966 as assistant professor of biology. A native of Clifton Forge where he attended public schools, Dr. Scott received the Ph.D. in botany from Virginia Polytechnic Institute in 1967. Earlier he had taught general science and served as chairman of the science department at Robert E. Lee Junior High School in Lynchburg. While there he participated in the National Science Foundation Program, co-sponsored by the University of Virginia's extension division. Other academic experience includes serving as research assistant to Dr. Brumfield at the Oak Ridge National Laboratories, three years as a teaching assistant at the University, and graduate work at the Mountain Lake Biological Station.

For the past two years Longwood seniors, participating in a survey, voted natural sciences the college's strongest department. It offers majors in biology, chemistry, physics, and general science, as well as courses in medical technology and pre-nursing, conducted in cooperation with the University of Virginia and Virginia Commonwealth University.

Dr. Scott is a member of the Virginia Academy of Science, American Association for the Advancement of Science, Botanical Society of America, Virginia Education Association, and Association of Southeastern Biologists.

His is married to the former Mary Lee Warriner of Amelia. They have a four-year-old daughter, Kathryn Page.

HOLLINS COLLEGE RECEIVES GRANT

Hollins College has received a \$143,600 grant from the National Science Foundation (NSF) to strengthen its academic program in the sciences and social sciences.

The three-year grant for the departments of biology, chemistry, economics, mathematics, politics, psychology, physics, sociology, and statistics was announced by Dean John Wheeler.

According to Dean Wheeler, Hollins received NSF support for five programs:

Visiting scientists: "Highly competent and regarded" scientists will be invited to spend a week on campus, meeting informally with students and faculty. Some will lead classes or seminars and/or give public lectures.

Faculty travel and research: Funds for these activities will be "substantially increased" for projects during the academic year and in the summer.

Special faculty leaves: Younger and non-tenured faculty, not now eligible for scholarly leaves, will receive support for post-doctoral research.

Student travel funds: A limited amount of money will be available for students "who need to utilize library and laboratory facilities not available at Hollins."

Faculty replacement: Additional personnel "on a temporary basis" will be hired to release regular faculty "to carry on research, undertake curriculum revision, or experiment with new teaching programs."

Under the latter part of the NSF grant, Hollins plans to bring a computer expert on campus to offer courses in this field and advise on the computer needs of the college and the use of the computer in scientific and institutional research.

One of the possible programs outlined in Hollins' proposal to the National Science Foundation was the establishment of a program in urban studies, including a research center focusing on the Roanoke area. It would be a teaching, research and service agency. Specialists, drawn from the Hollins faculty, would include those in metropolitan government, urban sociology and related areas, manpower and employment, social psychology, architecture and history of the city.

VISITING PROFESSORS AT MCV

Dr. Heribert Konzett, professor of pharmacology and toxicology at the University of Innsbruck, and Dr. Herbert Rowland, senior lecturer in clinical tropical medicine at the London School of Hygiene and Tropical Medicine, will be visiting professors for the 1969-70 academic year in the School of Graduate Studies at the Medical College of Virginia, Health Sciences Division of Virginia Commonwealth University.

Dr. Konzett, a past president of the German Pharmacological Society, will be a visiting professor

of pharmacology supported as a National Science Foundation Senior Foreign Scientist from September 1969 through August 1970. A native Austrian, he has conducted research studies in pharmacology at the University of Cambridge on a British Council Scholarship and research in the physiology departments of the University of Edinburgh and the University of London. He has been chairman of the Department of Pharmacology at the University of Innsbruck since 1960.

Dr. Rowland, at MCV as an A. D. Williams Scholar, will be a visiting professor in the Department of Biometry from August 1969 to July 1970. Dr. Rowland will use the Department of Biometry's computer and programs in path analysis studies of antimony kinetics, teach elementary statistics and assist as a medical consultant in the biometry program.

MOUNTAIN LAKE SUMMER SESSION

The University of Virginia has announced the program of graduate biological courses to be offered this summer at the Mountain Lake Biological Station in southwestern Virginia. They are as follows:

First Term—June 10 through July 14

Algology: Dr. Francis R. Trainor, University of Connecticut

Herpetology: Dr. Harry G. M. Jopson, Bridgewater College

Invertebrate Physiology: Dr. Fred A. Diehl, University of Virginia

Taxonomy of Seed Plants: Dr. A. Murray Evans, University of Tennessee

Second Term—July 16 through August 18

Animal Behavior: Dr. Richard B. Hemmes, Duke University

Ecological Genetics: Dr. David A. West, Virginia Polytechnic Institute

Mammalogy: Dr. Charles O. Handley, Jr., U. S. National Museum

Pteridology: Dr. Warren H. Wagner, Jr., University of Michigan

A limited number of National Science Foundation scholarships are available for research and study: (1) Post-doctorate for research, stipend \$1300; (2) Pre-doctorate for supervised research, stipend \$500; and (3) Post-graduate for training in field biology, stipend \$400. Preference is given for studies concerned with the biota of the region. Application blanks for these awards may be secured from the Director, Mountain Lake Biological Station, Department of Biology, University of Virginia, Charlottesville, Virginia 22903 and must be submitted before May 1, 1970.

General Notice To Contributors

The Virginia Journal of Science heartily welcomes for consideration original articles of technical or general interest on all phases of mathematics, the natural, physical and engineering sciences. Submission of an article for publication implies that the article has not been published elsewhere while under consideration by the Journal.

All articles should be typewritten (double-spaced) and submitted on good bond paper ($8\frac{1}{2} \times 11$ inches) in triplicate to the Editor. Margins should not be less than $1\frac{1}{4}$ inches on any border. Title, running title, authors, place of origin, abstract, figures, legends, tables, footnotes, and references should be on individual pages separate from the text. Technical abbreviations should follow consistent standard practices with careful avoidance of unnecessary neologistic devices. All pages (including illustrations) should be consecutively numbered in the upper right corner. A pencil notation of author names on the back of each page is helpful in identification.

Illustrations should be supplied in a form suitable for the printer with attention to the fact that a reduction in size may be necessary.

A good technical article generally contains an obligatory abstract before the text, an introduction, with reference to preliminary publications that may exist, an experimental section, results (which may be included in the experimental section), a discus-

sion, and conclusion. References are indicated in the body of the article by consecutively used numbers in parentheses. Although publication costs are high, attention should be given to relatively complete references (bibliographies) since the purpose of an article is to illuminate the significance of present and past findings, and not merely to obscure the past. The Journal reserves the right (generally exercised) to make page charges for articles in excess of 5 pages and to bill authors at cost for unusually complicated illustrative material.

Abbreviation of journals for references can be found in the 4th edition of the *World List of Scientific Periodicals*, Butterworth, Inc., Washington, D. C., 1963, and supplements. References should be checked carefully.

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1. Aiyar, A. S., and Olson, R. E., *Fedn Proc. Fedn Am. Soc exp. Biol.*, **23**, 425 (1964).
2. Chappell, J. B., Cohn, M., and Greville, G. D., in B. Chance (Editor), *Energy linked functions of mitochondria*, Academic Press, Inc., New York, 1963, p. 219.
3. Riley, G. A., and Haynes, R. C., Jr., *J. biol. Chem.*, **238**, 1563 (1963).

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- 3. Microbiology (Bacteriology)
- 4. Biology
- 5. Chemistry
- 6. Materials Science
- 6x. Space Science and Technology
- 7. Engineering
- 8. Geology
- 9. Medical Sciences
- 10. Psychology
- 11. Science Teachers
- 12. Statistics

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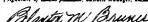
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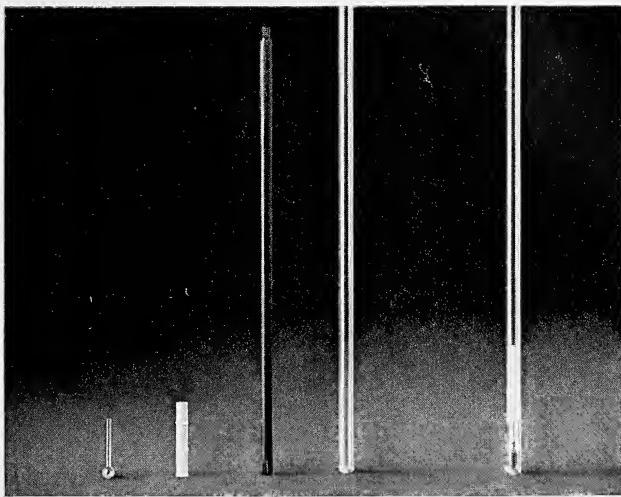
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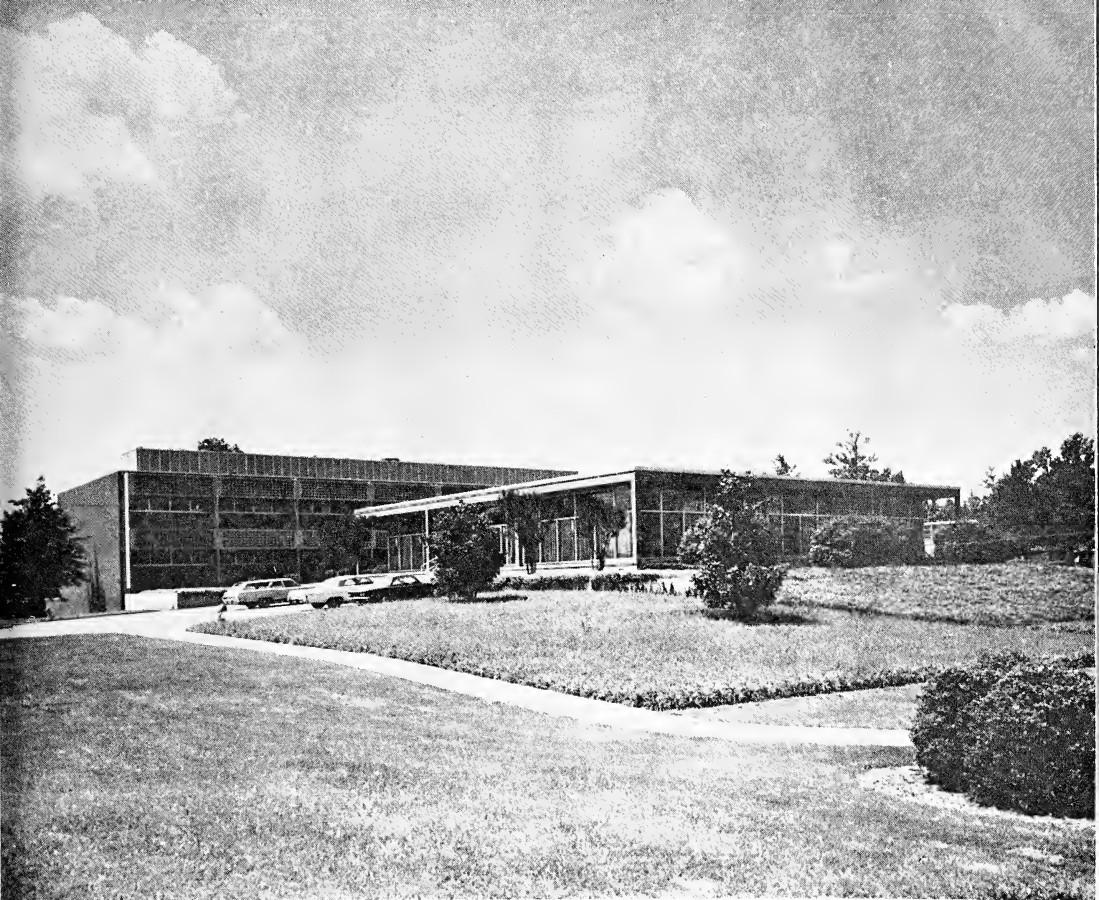
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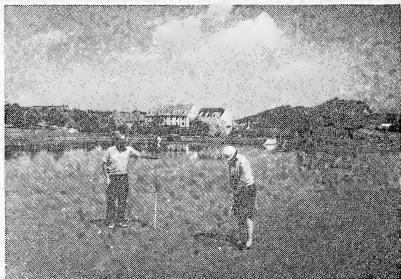
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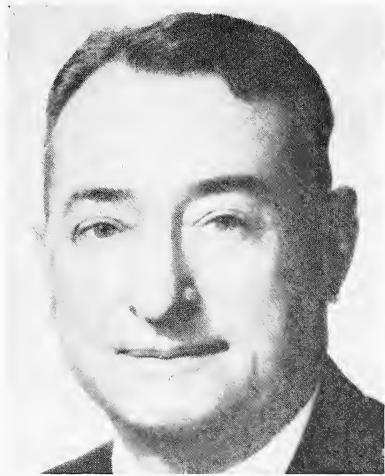
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The front cover is by Douglas C. Hensley.



Foley Foster Smith
1905-1969

The scythe of time has removed from our midst, but not from our memory, our friend and faithful colleague, Foley Foster Smith.

Born in Danville, Virginia, on December 6, 1905, Foley was educated in the public schools of Danville and the University of Virginia. After receiving his education in chemistry at the University, in 1927 he joined the E. I. du Pont de Nemours Company as an assistant chemist, where he worked for three years. In 1930 he joined the Tobacco By-Products and Chemical Corporation, where he worked until 1934 as a chemist. His next employer was the Virginia Alcoholic Beverage Control Board, where he worked from 1934 until his passing on August 9, 1969. He was made Director of the Division of Chemistry upon the retirement of J. Bernard Robb in July 1959 and served the Board with distinction for some thirty-five years.

During his tenure with the ABC Board, he served in the U.S.A.A.F. from January 1943 to October 1945. In his assignment with the Air Force, Foley came to be a nationally known expert in chemical gardening, hydroponics. During the war he was sent to Ascension Island and British Guiana to set up field laboratories in this specialty. It was during this tour of duty that he told the general, who was dressed in casual clothing, to wait until he washed his equipment before consenting to give the general a tour of the laboratory. It was only later that Foley realized that he was talking to General of the Army, H. H. (Hap) Arnold, thus becoming probably the only sergeant in World War II to tell a five-star general to wait and get by with it.

In addition to performing the duties of his chosen profession, he found time to be active in numerous civic and professional organizations. He was a member of the American Chemical Society, American Institute of Chemists, National Railway Historical Society, St. John's Masonic Lodge #36, Scottish Rite, Acca Temple Shrine, Westhampton Post #84 of the American Legion, Richmond Torch Club, American Society of Enologists, the Exchange Club and the Air Force Association.

Foley served two of his professional organizations with honor and distinction. He was Chairman of the Virginia Section, American Chemical Society, in 1946. After many years service to the Virginia Academy of Science as Secretary-Treasurer, he was elected President of the Academy and served during 1963-1964. As testimony of his devoted and long service to the Academy he was elected "Honorary Life Member" in May 1964; the only person so honored by the Virginia Academy of Science.

Foley and his white linen suit became legend at the annual meeting of the Academy where his memory will long be cherished. He loved the Virginia Academy of Science and gave unselfishly of his talents. His faith in its future was evidenced by a generous legacy to the Academy.

It has been said that the measure of a man is his service to others. Foley with his genial and sincere friendship, his devotion to duty, and the fulfillment of his responsibilities will stand tall among his many associates that had the opportunity to know and work with him. He was a man with deep emotions, he loved people and was loved for his loyalty to his friends.

"He has lived and the fruits of his labors live after him."

RANDOLPH N. GLADDING

Richard M. Cribbs

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Medical College of Virginia
Virginia Commonwealth University
Richmond, Virginia 23219
Received March 5, 1970*

Suppression of Structural Gene Mutations in Bacteria^{1,2}

A structural gene is a discrete linear sequence of nucleotide base pairs of the deoxyribonucleic acid (DNA) molecule that contains information for the sequence of amino acids in a protein. One strand of the double stranded DNA molecule is transcribed into a single strand of messenger ribonucleic acid (1), and the mRNA subsequently translated into protein. Each set of three bases (codon) specifies one amino acid (2,3). The specific order of amino acids determined by the transcribed nucleotide sequence of the mRNA (3) ultimately defines the properties and functions of the protein. A change in the order of DNA base pairs usually alters the properties of the protein, i.e., alters the gene's phenotype. Conceivably, a DNA base change could occur that does not alter the amino acid sequence of the protein. Since the genetic code is degenerate (4, 5) (more than one mRNA codon can specify the same amino acid) it is probable that mutations can occur that would not change the linear order of amino acids. For example, both CAU and CAC mRNA codons code for histidine (except where noted, the term codon refers to mRNA codons, changes in DNA nucleotides are, of course, reflected in mRNA). A single nucleotide substitution changing CAU to CAC would not alter the amino acid sequence since histidine would be inserted into the protein in either case. Most mutations that act in this manner would likely involve the third base of the codon, since mRNA codon-tRNA anticodon pairing here is less specific than that of the bases in the first two positions (6). The extent of phenotypic alterations caused by the mutation ranges from the production of a non-functional protein, or indeed no protein, to one that has catalytic activity approaching that of the wild type protein. A protein can also be produced from a mutated structural

gene that has a different amino acid sequence but activity roughly equal to the wild type enzyme.

Structural gene mutations may also have a secondary effect in addition to altering the product of the gene in which they occur. When the mutation occurs in a structural gene of an operon, the product(s) of the gene(s) on either side of the gene containing the mutation may be produced in lesser amounts than, or be less functional than, the wild type protein (7-9).

Reversal of the phenotype caused by the primary mutation may occur in a number of ways. A second mutation may occur at the same site (nucleotide) as the primary mutation and restore at least a partially functional protein. According to Fig. 1, single site second mutations at the same site as the primary mutations can result in three different codons—one of which is a true back mutation since it restores the original nucleotide sequence. The remaining two possible codons may or may not result in a functional product depending on which, if any, amino acid is inserted into the protein.

Phenotypic reversal is also caused by the occurrence of a second mutation at a site distinct from the primary mutation. In this case, the genome of the organism contains two mutations, the primary mutation and a second mutation (suppressor) which corrects, or suppresses, the effect of the primary mutation. Although the degree of correction varies, the genome of an organism containing a suppressed gene is generally less efficient than the wild type genome (11). Gorini and Beckwith (12) have classified the mechanism by which the suppressor corrects the primary mutations as either indirect or direct. In the former case, the suppressor mutation produces a product or alters cellular conditions so as to make the product of the mutated gene unnecessary to the survival of the cell. Alternatively, direct suppression alters the mutated gene product in such a way that makes it at least partially functional. This review is limited to the latter type of suppression and deals with the generalized mechanisms involved in both intragenic and intergenic suppressors of structural gene mutations in bacteria. Several comprehensive reviews of the genetic code (13-15), mutational

¹ Part of this review was presented at a Symposium on the Regulation of Enzyme Synthesis at the Fall Meeting of the Virginia Branch, American Society for Microbiology, University of Virginia School of Medicine, Charlottesville, October 10, 1969. Supported in part by NIH Grant GM-11098.

² Abbreviations and terms: A, adenine; C, cytosine; G, guanine; T, thymine; U, uracil; mRNA, messenger ribonucleic acid; tRNA, transfer ribonucleic acid; amino acid-tRNA (e.g., leucyl-tRNA, tRNA carrying leucine, etc.; tRNA^{amino acid} (e.g., tRNA^{leu}); tRNA species capable of accepting leucine, etc. Additional terms are described in the Glossary.

... CGA ...	Wild type DNA codon
... GCT ...	
... CTA ...	Mutant DNA codon
... GAT ...	
... CGA ...	Back mutation I (True)
... GCT ...	
or	
... CAA ...	Back mutation II
... GTT ...	
or	
... CCA ...	Back mutation III
... GGT ...	

FIG. 1—Possible back mutations of a mutant codon occurring at the same site as the original mutation. The mutations represent base replacements of the transversion (GC to TA, TA to GC and AT) and transition (TA to CG) types (10).

mechanisms (16, 17), the role of transfer RNA in protein synthesis (18), and suppression (12) have recently been published.

Intragenic Suppression

Mutations that suppress primary mutations directly have been classified according to their location in the genome of the organism (12). Intragenic suppressors are those that occur in the same gene as the primary mutation while those outside the mutant gene are intergenic, or extragenic, suppressors. Intergenic suppressor mutation may restore the mutant gene's phenotype in a number of ways. First, the suppressor mutation may occur in the same codon, but not, in adhering to the definition of suppression, at the same site as the primary mutation and in this way generate six different codons. Each codon so generated would contain two nucleotides that differ from the wild type codon. If the original primary mutation has resulted in a missense codon, then one or more of the six double mutant codons may cause insertion of an amino acid that (a) changes a partially active missense protein to a second more active missense protein, or, (b) changes a nonfunctional missense protein to a functional missense protein. Although (a) is feasible, it is difficult to distinguish mutant bacterial strains with only slight differences in their mutant proteins. With regard to (b), Yanofsky and co-workers (19-22) using *E. coli* have shown that a single site mutation changes the wild type glycine codon (GGA) to a mutant arginine codon (AGA) in the A protein of tryptophan synthetase. The tryptophan synthetase containing the missense amino

acid, arginine, is not enzymatically active (i.e. non-functional missense protein). A single nucleotide change in the AGA codon can result in six different codons, each containing two nucleotides that differ from the wild type codon, GGA (Table I). Each codon so generated must retain the first base as A, from the primary mutation, G to A. The second or third base may be either, A, U, G, or C (except for AGA, the mutant codon). The activity of the tryptophan synthetase produced in each case depends on which amino acid is specified by the doubly mutated codon (Table I).

If, instead of a missense codon, the primary mutation generates a nonsense codon then a second intracodon mutation may change the nonsense codon to a missense codon that produces (c) a non-functional missense protein, or (d) a functional missense protein. Strictly speaking, a second mutation that leads to (c) would not be considered a suppressor mutation since it does not restore any wild type phenotype. It may, however, act to overcome any polarity imposed on an operon by the original nonsense codon (discussed in the section on polarity). Analysis of revertants of nonsense codons in the alkaline phosphatase gene of *E. coli* (23, 24) illustrate (d). The nonsense codon UAG has been shown to give rise to five codons containing the primary mutation (the second letter, A) and an additional change in either the first or third letter by a single base change. Each of these five codons specify a missense amino acid which leads to a functional alkaline phosphatase protein (Table II).

A second type of intragenic suppression results from a mutation outside the codon containing the primary mutation. In this type of suppression, the primary mutation, which can only be a missense and not a nonsense codon, results in a nonfunctional missense protein. A second mutation, which must

TABLE I
INTRACODON SUPPRESSION OF THE MISSENSE AGA CODON
OF THE TRYPTOPHAN SYNTHETASE A PROTEIN OF *E. coli*.^a

CODON	AMINO ACID	ENZYME	
		FUNCTIONAL	NONFUNCTIONAL
Wild type GGA	Glycine	+	
Mutant * AGA	Arginine		+
Inactive revertants ** AAA	Lysine	-a	
	* AGG	Arginine	-a
Suppressed mutants ** ACA	Threonine	+	
	** AUA	Isoleucine	+
	AGU	Serine	+
	AGC	Serine	+

^a Modified from the results of Yanofsky *et al.* (22).

* Indicates the two nucleotides that differ from the wild type codon, GGA.

^a Protein containing lysine probably inactive; protein containing arginine inactive since it contains the same amino acid as the mutant.

TABLE II
INTRACODON SUPPRESSION OF THE NONSENSE UAG CODON
IN ALKALINE PHOSPHATASE OF *E. coli*.^a

CODON	AMINO ACID	PHENOTYPE
UGG	Tryptophan	wild type
UAG	none	negative ^a
** UAA	none	negative ^a
** UAC	Tyrosine	suppressed negative ^b
** UAU	Tyrosine	suppressed negative ^b
** AAG	Lysine	suppressed negative ^b
** CAG	Glutamine	suppressed negative ^b
** GAG	Glutamic Acid	suppressed negative ^b

UGG represents the wild type codon that mutates to the nonsense codon, UAG.

^a Modified from the results of Weigert, *et al.*, (23, 24).

^{*} Indicates the two nucleotides that differ from the wild type codon, UGG.

^b Protein not produced due to nonsense codon.

^b Functional protein produced.

also be a missense type, outside the primary mutant codon causes insertion of a second missense amino acid. The net result is that proteins with both missense amino acids are active while one containing either missense amino acid alone is non-functional. For example, Yanofsky *et al.* (25) have shown that a single base change results in glutamic acid replacing glycine in the tryptophan synthetase of *E. coli*. A second single site change, 36 amino acid residues (or 36 codons) away, results in the replacement of tyrosine by cysteine. Tryptophan synthetase with either the missense glutamic acid or cysteine at their respective sites is inactive. However, the presence of both missense amino acids at the sites designated are compensatory and yield a functional tryptophan synthetase. The corrective mechanism of this type of suppression is not known although it is speculated that the presence of both missense amino acids corrects tertiary structure alterations introduced into the protein by each of the missense amino acids (25).

The third type of suppression is correction of a frameshift mutation (2) by a second mutation. A frameshift adds to or deletes (+ and - frameshift, respectively) a small number of bases to or from the DNA. Since the code is triplet, a mutation that adds or deletes three, or multiples of three, bases does not shift the reading frame. Because transcription and translation begin at one end of the gene and proceed to the other, the base sequence of the structural gene beyond the site of the frameshift is altered (2) (Fig. 2). The gene could be translated if a shift in the reading frame does not cause a nonsense codon on the side of the mutation distal to the beginning of the gene. The number of missense amino acids it contained would undoubtedly render it inactive, unless the frameshift mutation occurred near the end of the gene causing sub-

→ direction of translation

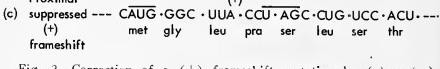
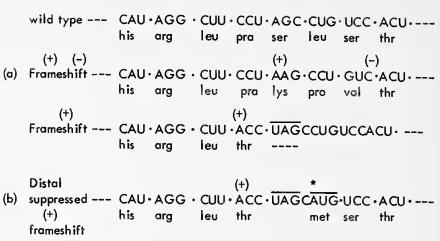


Fig. 2—Correction of a (+) frameshift mutation by (a) a (-) frameshift mutation, (b) a mutation to an initiator codon, AUG on the distal side of the (+) mutation and nonsense codon UAG, and (c) an initiator codon generated on the proximal side of the (+) mutation and nonsense codon.

(+), base inserted; (-), base deleted.

*, Base changed giving rise to initiator codon AUG.

stitution of a minimal number of incorrect amino acids. A second mutation of the opposite sign prior to or after the primary frameshift would act as a suppressor by correctly rephasing the reading frame (a, Fig. 2). If the initial frameshift mutation does not generate a nonsense codon between it and the second frameshift of opposite sign then a protein would be produced. The activity of such a protein would be variable, depending on which amino acids were inserted by the missense codons between the frameshift mutations (26, 27). Usually however, a shift in the reading frame generates a nonsense codon that stops translation and/or transcription at the point of its location, and in conjunction with its release factor (28), frees the incomplete protein from the mRNA-ribosome complex (29-31). It has been suggested that nonsense codons arising as a result of frameshift mutations (or independently arising nonsense codons) can be corrected by a second mutation that changes an existing codon to one of the initiator codons (32). After encountering a nonsense codon the ribosome appears to release the protein fragment it has made up to the nonsense codon and moves both backward and forward along the mRNA before most of them disengage from the mRNA (33, 34). If a second mutation occurs near the nonsense codon and generates an initiator codon, then some of the ribosomes will be reinitiated at this point and continue to translate the gene. Obviously a functional protein will be produced only if the initiator codon correctly rephases the ribosome on the mRNA (b, Fig. 2). If the initiator codon is generated on the proximal side of a (+) frameshift then it must be generated in a (-) phase in order to translate through the (+) frameshift without being incorrectly phased by the latter (c, Fig. 2). The activity of the suppressed proteins produced by such

mechanisms appears to be higher when both the initiator and nonsense codons are located close to the beginning of the gene and proximal to one another (32). Primary mutations that produce nonsense codons directly could also be suppressed by a second mutation leading to an initiator codon on the distal side of the nonsense codon.

Intergenic Suppression

Much progress has been made in clarifying the structure of transfer ribonucleic acid (tRNA) and its role in protein synthesis (recently reviewed, 18). This knowledge has been essential in determining the mechanisms of intergenic suppression. Of the tRNAs that have been studied each consists of about 80 nucleotides arranged in the form of a cloverleaf (35). Recent experiments are beginning to clarify the function and location of two regions of the tRNA molecule. The first of these is the stem region (all having a common ending, CCA) which, recent evidence suggests, acts as the primary recognition site for a specific enzyme, the aminoacyl-tRNA synthetase, responsible for binding a specific amino acid to the appropriate tRNA (36-39). Mutations in the aminoacyl-tRNA synthetase could well be involved in suppression. It has been shown that the rates of aminoacylation differ from one tRNA to another (40, 41). These rates may be further altered by mutations in the aminoacyl-tRNA synthetase genes (40). An increase in the aminoacylation rate of those tRNAs involved in suppression would make the aminoacylated tRNA more plentiful and speed translation of an already suppressed (missense) codon (or of any codon specifying that tRNA). The end result is production of more of a suppressed missense protein, hence more efficient suppression. The second region is the anticodon, a sequence of three bases, unique to each tRNA and (almost) completely specific for a particular codon on the mRNA. A change in the base sequence of either of these tRNA regions does not necessarily interfere with the function of the other (36, 42-44). For example, it has been shown that when the anticodon, GUA, of tRNA^{tyr} mutates to CUA, the tRNA is still amino-acylated with tyrosine (42), although in some cases, changes in bases of, or near, the tRNA's anticodon appear to slow its aminoacylation rate (40).

Most extragenic suppressors that have been reported are explained by mutational changes that occur in the bases of the anticodon of one or another tRNA species. The genes for the various tRNAs are scattered over the genetic map and are transcribed seemingly independent of one another. Consequently, a mutation in a tRNA gene will be transcribed into the tRNA molecule. Many of these mutations will prevent the tRNA from fulfilling its role in protein synthesis and thus be lethal to the cell. Alternatively, some of these mutant tRNAs are able to correct what would otherwise be a lethal mutation in a structural gene. Translation of a gene is prevented by the presence of a nonsense codon in that gene (45). The resultant lethality

can be overcome by a mutation in a tRNA anticodon that permits it to pair with the nonsense codon, thus translating it. For example, the nonsense codon UAG is not translated because tRNAs containing the CUA or UUA anticodons, necessary for pairing with UAG, are not present in the cell. [According to Crick's wobble theory (6), the nonsense codon UAG can be translated by UUA and CUA anticodons; the nonsense codon UAA can only be translated by UUA; and the third nonsense codon UGA can be translated by UCA. Therefore, a suppressor tRNA that suppresses UAG but not UAA must have CUA as its anticodon. UAA can only be translated by UUA. UGA can be translated by UCA, an anticodon that should be able to also translate UGG, the tryptophan codon, and for this reason probably does not exist (46) (Table III)]. With regard to UAG then, any anticodon that can mutate to either CUA or UUA can translate, i.e. suppress, the UAG codon. The amino acid specified at UAG would be limited to those carried by tRNAs whose anticodon can, by a single mutation, change to either CUA or UUA (Table III). According to the model proposed by Garen (16) whether UAG is being suppressed by CUA or UUA anticodon can be resolved since, CUA will only suppress the UAG codon, while UUA will suppress either UAG or UAA codons. Of the possibilities listed in Table III the following amino acids, along with their proposed anticodons and number designation, have been demonstrated in the suppressed alkaline phosphatase of *E. coli* (47-50): serine, *su* 1, CGA to CUA; glutamine, *su* 2, CUG to CUA; tyrosine, *su* 3, GUA to CUA; tyrosine, *su* 4, either GUA or AUA to UUA since *su* 4 translates either UAG or UAA as tyrosine; lysine, *su* 5, UUU to UUA for the same reason; leucine, *su* 6, anticodon involved not yet reported. Glutamine has also been shown to be inserted in response to UAG in the tryptophan synthetase of *E. coli* (51). Since the properties of this suppressed mutant differ from *su* 2, it has been designated *su* 7 (see below).

There is, however, a second effect of an anticodon mutation. Transfer RNA^{gln} with the anticodon CUG is normally specified by codon CAG. When CUG changes to CUA it no longer recognizes its normal codon CAG and, as a consequence, does not deliver glutamine to any CAG codon anywhere in the entire genome of the cell. Current base pairing theory indicates that CAG can be translated by either CUG or UUG anticodons. Presumably in this case, tRNA with the UUG anticodon would translate not only its normal codon, CAA, but also the CAG codon. Table III shows that not all codons have such alternate anticodons. UAC is a tyrosine specifying codon that can only be translated by anticodon GUA. Therefore, when GUA is changed to CUA, as has been shown to be the case with *su* 3 (42), it would no longer be able to translate the UAC codon, although in this specific case, the GUA to CUA mutation is not lethal to the cell. This and other similar findings seem to indicate that not all tRNA species present

TABLE III
ANTICODONS THAT CAN BE ALTERED TO TRANSLATE
UAG BY A SINGLE SITE MUTATION

Anticodon Mutation to CUA	Codon(s) Normally Translated	Alternate Anticodons	Amino Acid Inserted at UAG*
CUG	CAG	UUG	gln
CUC	GAG	UUC	glu
CUU	AAG	UUU	lys
CGA	UCG	UGA	ser
CCA	UGG	UCA	try
CAA	UUG	UAA	leu
UUA ^a	UAA, UAG	--	none
AUA ^b	UAU	GUA	tyr
GUU ^b	UAC	none	tyr
		UAU	
<hr/>			
Anticodon Mutation to UUA			
UUG	CAA	none	gln
	CAG	CUG	
UUC	GAA	none	glu
	GAG	CUC	
UUU	AAA	none	lys
	AAG	CUU	
UGA	UCA	none	ser
	UCG	CGA	
UAA	UUA	none	leu
	UUG	CAA	
CUA ^c	UAG	UUA	none
UCA ^c	UGG	CCA	try
	UGA	none	

* Amino acid abbreviations: gln, glutamine; glu, glutamic acid; lys, lysine; ser, serine; try, tryptophan; leu, leucine; tyr, tyrosine.

^a Both UUA and GUU anticodons can mutate to either CUA or UUA.

^c tRNA with UCA anticodon probably does not exist since it can translate either UGG (tryptophan) or UGA (nonsense).

in the cell are necessary for its survival, i.e. some tRNAs are dispensable (16). The relative amounts of tRNAs carrying the same amino acid (isoaccepting tRNA) are variable and classified as major and minor species. The suppressor tRNAs that have been studied belong to the minor species of isoaccepting tRNAs (42, 52, 53). The minor species of tRNA^{try} that suppresses UAG has recently been shown to be produced by two identical adjacent genes (54). In view of their apparent dispensability it is surprising to find two genes present in the genome for a minor species of tRNA. The viability of a cell containing the *su* 3 tRNA^{try} could be accounted for because such a cell would produce

two types of minor species tRNA^{try}, one with the wild type anticodon, GUA, and one with the suppressor anticodon, CUA. Whether this is the case or not is unclear at this time since it seems that cells lacking both these minor species tRNA^{try} genes are viable.

Most amino acids must be delivered to the ribosome-mRNA complex by major species of tRNA and this role in protein synthesis would preclude them from acting as suppressor tRNAs. Moreover, it would be predicted that suppressor mutations occurring in the genes for major species of tRNA would be lethal. Experimental support for this has recently been provided (51, 55). A suppressor tRNA has been isolated that inserts glutamine at a UAG codon in *E. coli* tryptophan synthetase, and does it much more efficiently than *su* 2, which also translates UAG as glutamine. However, the new tRNA^{gln} mutation (*su* 7) is lethal to the cell and can only be detected in a partial diploid cell that contains genes for both the wild type tRNA^{gln} and its mutant allele, *su* 7. Apparently tRNA^{gln} *su* 2 is a dispensable minor species since it is non-lethal and a less efficient suppressor than tRNA^{gln} *su* 7. *su* 7 is presumed to be a major tRNA^{gln} species and is responsible for translating glutamine codons along the entire genome. If it is unable to carry out this function, the cell cannot survive.

The reduced growth rate of cells containing suppressors could be a direct result of the reduced quality or quantity, or both, of the missense protein produced by the suppressed gene. As Garen (16) points out the small supply of minor species suppressor tRNA may slow down translation at the suppressed nonsense codon, reducing the level of protein normally produced by the wild type gene. It is improbable that the sole function of minor tRNA species is to suppress lethal structural gene mutations, since cells containing suppressors grow more slowly, at least in the laboratory, and are at a selective disadvantage. A change in its role (i.e. to suppression) may in itself be the cause of growth inhibition or, alternatively, it may place a burden on the major tRNA species with the same results. Aside from the reduced quantity, it would not be surprising if the protein produced by the suppressed structural gene has reduced activity since it contains a missense amino acid.

Missense mutations of structural genes are also suppressible by intergenic suppressors (51, 56-59). Whereas suppression of nonsense mutants occurs by insertion of an amino acid where previously none was specified, missense suppression is an exchange of one amino acid for another. As in nonsense suppression it is thought to involve changes in tRNA. More than likely most missense suppressors would be lethal to the cell, for if a tRNA species changed so that it inserted a different amino acid in response to a particular codon, only at one codon (the missense codon) would the changed tRNA be beneficial to the cell; at all other places along the genome, where the same codon occurred, the wrong amino acid would be inserted. Two groups of workers have demonstrated mis-

sense suppression in tryptophan synthetase of *E. coli* (57, 58). In one instance a mutation changes the wild type codon GGA (glycine) to AGA that specifies arginine. This replacement makes the tryptophan synthetase nonfunctional. A revertant strain was isolated that produced two different synthetase proteins, one inactive containing arginine and one active containing glycine (56). Recent evidence shows that this type of revertant is probably diploid for the tRNA^{Gly} gene in question (51). The diploid cell contains a wild type gene producing normal tRNA^{Gly} and its mutant allele producing altered tRNA^{Gly} that translates AGA as arginine. The altered tRNA^{Gly} represents a major species of tRNA^{Gly} since it is lethal to the cell in the haploid state. It has also been reported (59) that conversion of L-ribulose to L-ribulose-5-phosphate by a functional missense kinase is increased by the presence of an intergenic suppressor. Whether this intergenic suppressor increases the amount of, or quality of, the kinase (or is due to an altered tRNA) has not yet been resolved.

It has generally been thought that frameshift mutations were suppressible only by the intragenic mechanisms described above. There is now evidence that frameshift mutations can be suppressed by intergenic suppressors (60–62). Although the mechanism of this type of suppression remains obscure, B. N. Ames (stated in 60) has suggested a model similar to that used to explain intragenic suppression of frameshift mutations (b, c, Fig. 2). The frameshift mutation generates a nonsense codon that disorients the translating ribosomes. When the ribosomes do not encounter a nearby initiator codon, as they are proposed to do in intragenic suppression, most of the ribosomes disengage from the mRNA. In one case studied, the frameshift mutation is suppressible by an intergenic UGA suppressor (60). It is suggested that disoriented ribosomes encounter an initiator codon in a region prior to the frameshift mutation. An additional restriction is that the initiator codon must be located in such a manner that the ribosome is rephased properly when it translates through the original frameshift mutation. If a UGA nonsense codon follows the initiator codon, but precedes the original frameshift mutation, the ribosome will be disoriented again. However, in this case, the presence of the UGA suppressor enables translation of the UGA codon and the remainder of the gene.

Polarity and Suppression

Some mutations occurring in structural genes of operons may affect the products of other genes in the same operon. Mutations affecting the products of genes located on their operator-distal side are termed polar mutants (7, 8). Mutations affecting gene products on their operator-proximal side (antipolar mutations) have also been described (9, 63–65). However, these differ from polar mutants in that they affect the function of the gene's product rather than the gene's transcription and/or translation as do polar mutants. It has been well substantiated that ribosomes release newly formed

protein fragments when they encounter nonsense codons (29–31). There is also evidence that when translation stops at a nonsense codon, transcription also ceases at this point with subsequent release of mRNA fragments that have been transcribed up to the site of the nonsense codon (66–68). As pointed out by Martin (69) the presence of mRNA fragments is not conclusive evidence that some mRNA transcription is stopped by nonsense codons. It is possible that the entire polygenic mRNA is transcribed and then fragmented by nucleases if not protected by ribosomes as the mRNA is during translation. By far, most polar mutants described reduce the level of proteins encoded by operator-distal genes (34, 63, 70–72). Some mutations in a structural gene of the L-arabinose operon cause an increase in the protein of operator-distal genes (69, 70). Whether these mutations function at the level of transcription or translation has not been resolved. Although the exact mechanisms causing polarity are not clear, it is generally agreed that it results from fewer molecules of mRNA, from the operator-distal genes, being transcribed or translated. In those cases examined, the quality of the proteins produced by genes operator-distal to the polar mutation does not appear to be altered (73, 75). From this brief description, it would seem that any disturbance of the bases in the gene that reduces the probability of subsequent genes being translated would have a polar effect on those same genes.

The causes of polarity can be broadly classified into frameshift mutations, nonsense mutations, and gross changes such as deletions or additions of more than a few bases (76–78). Except for one operon (59, 79) missense mutations have been reported to be nonpolar (34, 63, 70–72). There seems to be no stringent reasons why missense mutations cannot be polar. The basis for their polarity can be argued on the quantity (or lack of same) of minor tRNA species. If, for example, a mutation resulted in a codon specifying a minor species of tRNA then one would expect this codon to be translated at a slower rate than the wild type codon. In fact, this same argument has been used to explain incomplete suppression, that is, the failure of suppressors to restore activity to wild type level (16, 42, 44, 52, 53). In this case the missense codon could act as a modulator (80) not only for translation of the gene in which it occurs but also for genes operator distal to it.

From the discussion of frameshift and nonsense mutants in the first section, it can be seen that the polar effect can be relieved by suppressing the mutation that caused it. A frameshift mutation can cause a shift in the reading frame which may not be corrected at the beginning of the next gene to be translated. As a result, the sequence of bases would be incorrectly phased and a nonfunctional protein would be produced (78). A more likely alternative is that translation of the distal genes would not take place due to incorrect phasing of the ribosome at the beginning of the next gene. A second frameshift mutation of the opposite sign

would correctly rephase the reading frame and consequently relieve polarity. The efficiency with which the second frameshift (intragenic suppressor) corrected the polar effect would depend on the relative location of the two mutations as discussed in the section on intragenic suppression. Nonsense codons, arising from a primary mutation, or as a result of a reading frame shift, are known to terminate translation and cause release of the protein fragment (29–31), made up to that point, from the mRNA-ribosome complex. The degree of polarity, as a result of nonsense codons, will depend on how many of these ribosomes are not disengaged from the mRNA and become properly reinitiated at the beginning of the next gene. A suppressor tRNA decreases the polarity imposed on the distal genes by making the nonsense codon translatable. This not only restores, to some degree, translation of the gene containing the nonsense codon, but also translation of the distal genes.

If nonsense mutations are polar by the mechanism described above, then an increase in the tRNA specified by the missense codon would presumably increase the translation rate of the missense codon. An increase in the amount of a specific tRNA could be achieved in a number of ways. Since the rate of tRNA transcription is probably regulated (44), mutations in this regulatory region could result in an increase of the quantity of a specific tRNA. Alternatively, the aminoacylation rate of the tRNA in question could be changed either by regulatory mutations in the aminoacyl synthetase gene itself (81, 82) or by modifications of the recognition site of the tRNA that would facilitate aminoacylation. While these ideas concerning missense polarity and their suppression are speculative, they are attractive from the standpoint that they can be tested.

Summary

A normal structural gene contains a sequence of nucleotide pairs that specifies a functional protein. A mutation alters the sequence of nucleotides in the gene in which it occurs, thus altering the protein product of the gene. It may also affect the function of nearby genes. A second mutation may take place to suppress, or more properly, to correct, the error imposed on the gene(s) by the first mutation. The suppressor mutation can occur in the same gene or in a gene located somewhere else on the chromosome. Regardless of location, the suppressor mutation acts in a compensatory manner at the level where the amino acids are joined together to form a functional protein.

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Glossary

Initiator codon—codons that permit initiation of translation. They have been identified as GUG, AUG, and UGA.

Missense codon—a codon that differs in its base arrangement from the corresponding (allelic) wild type codon. A missense codon specifies a missense amino acid, that is, one that differs from the amino acid occupying the same position in the wild type protein. A missense protein contains a missense amino acid and may be functional or nonfunctional.

Nonsense codon—does not specify any amino acid and terminates formation of the polypeptide being synthesized on the ribosome. Also called chain terminators. Nonsense codons are UAG, UAA, and UGA. Whether UGA has nonsense status in the enteric bacteria is questionable. Amber and ochre are synonyms for UAG and UAA, respectively.

Operon—a group of adjacent structural genes and their controlling element, the operator. Transcription of the DNA into a single mRNA molecule and subsequent translation of the mRNA both begin at the operator end of the mRNA. If the mRNA contains information from more than one gene it is polygenic or polycistronic. Operator-proximal genes are located close to the operator, the remainder are operator-distal.

Reading frame—begins at a definite point at the operator end of the mRNA and proceeds by sets of three nucleotides to the end of the gene.

Transcription—the sequential synthesis of all species of RNA (tRNA, mRNA, and ribosomal RNA). The sequence of bases in all RNA species is determined by the base sequence in the DNA template.

Translation—the synthesis of a protein whose amino acid sequence is determined by the nucleotide sequence in the mRNA.

Wobble hypothesis—one species of tRNA with its specific anticodon can pair with more than one type of mRNA codon. There is strict pairing between the first two nucleotides of the codon and anticodon. Pairing between the third nucleotides is not strict. The predicted pairing at the third position is, U with A or G; G with U or C; C with G; A with U; anticodon—codon, respectively.

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Proton Magnetic Resonance Studies on Organophosphorus Pesticides

I. Doubling of Resonances Induced by Asymmetry

Abstract—Doubling of nuclear magnetic resonances of certain organophosphorus pesticides such as a number of esters of phosphorodithioic acid has been observed at 100 MHz and is attributable to molecular asymmetry.

Nuclear magnetic resonance techniques are useful in identification (1) and analysis (2, 3) of organophosphorus insecticides. The proton spectra at 60 MHz of many of these compounds have been reported (1).

In general, the spectra reported for these compounds are in accord with the resonance multiplicities that would be predicted without consideration of possible doubling (4, 5, 6) of some resonance lines due to molecular asymmetry. Only two examples (dyfonate (1), trichlorofon (7)) of such doubling have been reported for organophosphorus pesticides, although this effect is quite common in other phosphorus compounds (8, 9, 10). We have examined a number of such pesticides at 100 MHz and find the increased multiplicity to be observable in more cases than heretofore indicated by the literature.

Spectra were recorded on carbon tetrachloride or chloroform solutions of the pesticides studied, using a Varian HA-100 spectrometer locked on internal TMS and operated at 0.5 Hz resolution in frequency sweep mode. Chemical shifts are accurate to $\pm 0.02 \delta$; coupling constants, to ± 0.1 Hz. Table I gives the 100 MHz spectral parameters for the alkoxy groups of a number of pesticides. The structures of these compounds and of others referred to in the text are shown in Fig. 1. Δ_{asym} represents the observable separation, due to magnetic non-equivalence induced by asymmetry, of the P-OCH₃ protons.

A completely interpreted spectrum of ethion, typical of those recorded in the course of this work, is depicted in Fig. 2.

Broadening of P-O-CH resonance lines, suggestive of unresolved splitting due to asymmetry, was observed in the spectra of 0, 0-diethyl O-(2-isopropyl-4-methyl-6-pyrimidyl) phosphorothioate (diazinon) and 0, 0-dimethyl-S-phthalimidooethyl phos-

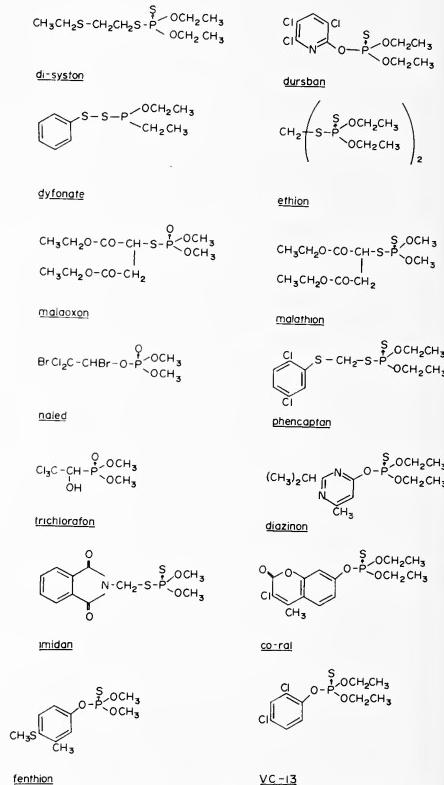


FIG. 1.—Structures of organophosphorus pesticides referred to in text.

TABLE I
Values in Hz

COMPOUND	$J_{P,OCH}$	J_{OCH_2,CH_3}	J_{P,OCH_2,CH_3}	$\Delta_{\text{asymmetry}}$
naled ^a	12.0, 11.9	—	—	1.1
malathion ^b	15.6	—	—	1.4
phenaceton ^c	10.0	—	—	2.1
dursban ^d	9.9	7.2	1.1	0.8
trichlorofon ^e	11.0	—	—	2.2
di-syston ^f	10.0	7.8	—	1.5
ethion ^g	10.1	7.2	0.6	1.6
dyfonate ^h	j	7.0	<0.6	j
malaoxon ⁱ	12.9	—	—	2.0

^a 1, 2-dibromo-2, 2-dichloroethyl dimethyl phosphate
^b 0, 0-dimethyl-S-(1, 2-dicarbethoxyethyl) phosphorodithioate
^c 0, 0-diethyl-S-(2, 5-dichlorophenylthiomethyl) phosphorodithioate
^d 0, 0-diethyl-O-(3, 5, 6-trichloro-2-pyridyl) phosphorothioate
^e 0, 0-dimethyl (1-hydroxy-2, 2-trichloroethyl) phosphonate
^f 0, 0-diethyl-S-2(ethylthio)ethyl phosphorodithioate
^g 0, 0, 0'-tetraethyl-S, S'-methylene-bis-phosphorodithioate
^h 0-ethyl-S-phenyl-ethylphosphonodithioate
ⁱ 0, 0-dimethyl-O-(1, 2-dicarbethoxyethyl) phosphate

^j 17 lines resolved for -OCH₂ group, but pattern was not a first-order one.

phorothioate (imidan). Such broadening was not observed for a number of other pesticides, including 0, 0-diethyl-0-3-chloro-4-methyl-1-oxo-2H-1-benzopyran-7-yl phosphorothioate (co-ral), 0, 0-dimethyl-0-4-[4-(methylthio)-m-tolyl] phosphorothioate (fenthion) and 0, 0-diethyl-0-(2, 4-dichlorophenyl) phosphorothioate (VC-13). It appears, therefore, that the presence of an asymmetric center need not always result in observable resonance doubling. Indeed, in over half the compounds we have examined, even at 100 MHz, such doubling was

not seen. Consequently, the phenomenon should not be unexpected when it occurs, but failure to observe it should not be taken as proof of molecular symmetry. Apparently, esters of phosphordithioic acid are more likely to exhibit resonance doubling than are phosphates or thiophosphates; of the nine cases here reported, six were phosphorodithioates.

Future publications will report complete 100 MHz spectra of organophosphorus pesticides, as well as various long-range P-H couplings, e.g., to the aromatic proton of dursban, that we have observed.

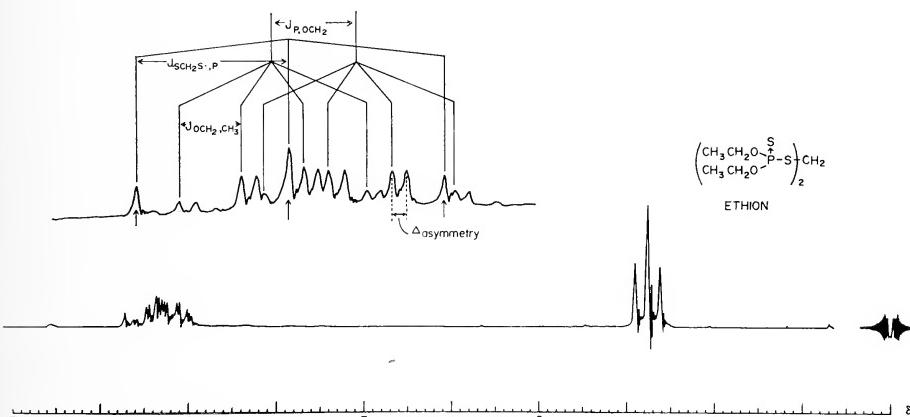


FIG. 2—NMR spectrum of Ethion. The triplet at 1.38 δ , $J_{CH_2,CH_2} = 7.2$ Hz, is due to the methyl groups. The methylene protons (triplet at 4.19 δ , $J_{P,-S-CH_2-S} = 17.5$ Hz, due to $-S-CH_2-S-$, superimposed upon octets at 4.20 δ and 4.21 δ , $J_{CH_2,CH_2} = 7.2$ Hz, $J_{P,OCH_2} = 10.1$ Hz, due to $-OCH_2-$) appear at lower field. In the enlarged trace, only the lower field octet has been analyzed, as the other one is identical to it. Arrows denote the triplet at 4.19 δ .

Summary

A proton magnetic resonance study of some phosphorodithioates, phosphates and thiophosphates illustrates the phenomenon of resonance doubling induced by asymmetry in a number of organophosphorus pesticides.

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The Internally Sensitized Photocyclization of Safrole

Abstract—The irradiation of safrole (1-allyl-3,4-methylenedioxobenzene) (**I**) in methanol solution gave 1-cyclopropyl-3,4-methylenedioxobenzene (**II**), as the exclusive product. Isosafrole (1-(3,4-methylenedioxophenyl)-1-propene) was shown not to be an intermediate in the photocyclization, which apparently is the result of internal photosensitization *via* excitation of the methylenedioxophenyl group.

Safrole is a major constituent of oils of sassafras, star anise and camphor, and minor constituent of oils of nutmeg, mace, cinnamon leaf, wild ginger and California bay laurel. It is used in certain pharmaceutical preparations, in the manufacture of heliotropin (piperonal) and the pesticidal synergist piperonyl butoxide, and is itself an active insecticidal synergist for pyrethrum and carbaryl (1-naphthyl-N-methyl carbamate).

Our interest in pesticidal synergists and essential oil components led us initially to examine the photochemistry of piperonal (**I**). The present communication reports an example of propene-to-cyclopropane photocyclization, apparently internally sensitized by the phenyl group.

The photochemical interconversion of phenyl substituted propenes and cyclopropanes has been extensively examined in recent years (1–8). With few exceptions (2, 7), the double bond in the propenes studied was conjugated with one or more phenyl groups, so that it was included in the chromophore initially excited by the output of the light source. However, in the case of safrole, the olefinic bond is isolated from the methylenedioxophenyl chromophore, and is transparent to the incident radiation. Hence, photochemical energy transferred to that double bond must first have been absorbed by the benzene ring, that does absorb at the wavelengths emitted by the lamp and filter combination used here.

A solution of safrole (**I**) (21.5 g.) in absolute methanol (450 ml.) was irradiated for 89 hr. with a 450 watt Hanovia mercury lamp equipped with a vycor filter (cut-off 210 $\text{m}\mu$, 50% transmission at 240 $\text{m}\mu$). The photolysis mixture then contained **I** and an isomeric product, **II**, in 3.43:1 ratio, as well as several minor (< 1%) products. **II**, separable by preparative GLC (175°, OV-17) was identified,

from its spectra, as 1-cyclopropyl-3, 4-methylenedioxobenzene.

NMR (CCl_4 , 100 MHz): 3H complex absorption at 6.4–6.58 (aromatic protons); 2H singlet at 5.79 δ (methylenedioxo group); 1H complex multiplet at 1.76 δ (C–H of cyclopropyl group); 2H multiplet at 0.81 δ and 2H multiplet at 0.55 δ (CH_2 – CH_2 of cyclopropyl group).

UV (EtOH): end absorption at 206 $\text{m}\mu$, λ_{\max} at 238 $\text{m}\mu$ (ϵ 3690) and at 290 $\text{m}\mu$ (ϵ 2870) characteristic of methylenedioxophenyl group (9).

Mass spectrum: molecular ion at m/e 162.

Analysis: Calcd. for $\text{C}_{10}\text{H}_{10}\text{O}_2$: C, 74.05%; H, 6.22%. Found: 73.85%; H, 6.09.

Spectra identical to those of **II** were obtained for independently synthesized 1-cyclopropyl-3, 4-methylenedioxobenzene. Piperonal was treated with methylmagnesium bromide to give 1-(3, 4-methylenedioxophenyl)-1-hydroxyethane, which on dehydration (10) over potassium bisulfate at 160° gave 3, 4-methylenedioxystyrene; this in turn underwent reaction with Simmons-Smith reagent (11) to give a low yield of **II**.

This cyclization also took place, but with decreased yield of **II**, when the lamp output was filtered through corex (cut-off 260 $\text{m}\mu$, 50% transmission at 290 $\text{m}\mu$). However, when a pyrex filter (cut-off 280 $\text{m}\mu$, 50% transmission at 310 $\text{m}\mu$) was used, the cyclization was almost completely suppressed (< 4% conversion to **II** after 72 hr.). These observations suggest that the reaction proceeds by initial excitation of the 289 $\text{m}\mu$ (ϵ 3880) transition (12) of safrole, with subsequent transfer of energy to the allyl group. Such intramolecular photosensitization has been observed in other systems (13–15).

Irradiation (vycor filter, 44 hr.) of a 5% solution of **II** in methanol did not result in the formation of detectable amounts of **I**, but small amounts (< 5%) of unidentified photolysis products, possibly the result of ionic photoaddition of methanol leading to scission of the cyclopropane ring (16), were observed. This demonstrates that, although the observed rate at which **I** is converted to **II** decreases substantially as the reaction progresses and more **II** accumulates in solution, that decrease is not due to a photoequilibrium between **I** and **II**. Presumably, **II** competes with **I** for the incident radiation, or the

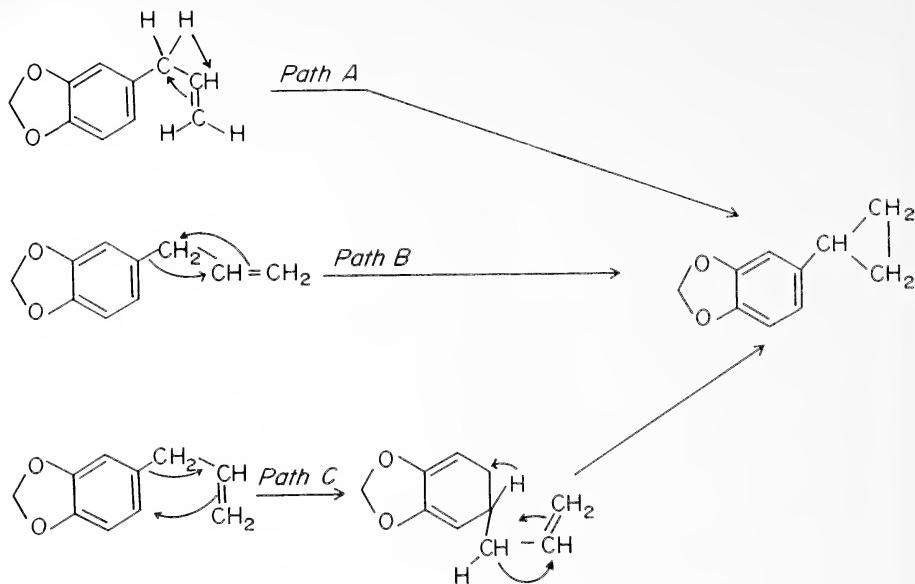


FIG. 1—Possible mechanisms for the photocyclization of safrole.

unidentified photoproducts of II may quench the reaction.

To eliminate the possibility that the reaction proceeds *via* isomerization to the conjugated olefin, iso-safrole (1-(3, 4-methylenedioxyphenyl)-1-propene) was irradiated under the conditions used for safrole. *Cis-trans* isomerization and reaction to give 5 products of high GLC retention time took place, but neither I nor II were detected.

Most previous studies of propane photocyclizations did not conclusively establish whether the electronic state involved in the transformation had singlet or triplet character. Zimmerman (8) has shown that the photoreaction of 1, 1, 5, 5-tetraphenyl-3, 3-dimethyl-1, 4-pentadiene to give 1, 1-diphenyl-2, 2-dimethyl-3 (2, 2-diphenylvinyl) cyclopropane took place *via* both singlet and triplet states, but that most of the reaction proceeded *via* the first excited singlet. In the present case, which involves an *unconjugated* double bond, it is not possible to extrapolate this result with confidence. Certainly, in view of the known efficiency of benzene and its derivatives as triplet sensitizers, it is attractive to postulate a triplet state for the reactive intermediate.

Previous work also shows that this type of cyclization (Fig. 1) can proceed *via* hydrogen (path A) or phenyl (path B) migration. A third mechanistic possibility, that cannot be excluded and which, to the authors' knowledge, has been over-

looked by previous workers, is depicted in path C. To distinguish between these three possible reaction pathways, work is in progress toward the synthesis and photolysis of safroles labeled with deuterium at the terminal methylene and in the benzylic positions.

Further studies are also in progress to explore the significance of the formation of II from the standpoint of environmental health considerations, such as its physiological activity and metabolic fate.

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Chaetonotus Bisacer Greuter from Mountain Lake Biological Station in Virginia*

Abstract—A gastrotrich, *Chaetonotus bisacer* G., is reported from a U. S. source for the first time.

In 1917, Greuter (1) described a Chaetonotid gastrotrich, *Chaetonotus bisacer*, from Switzerland. Among its distinctive features are a girdle-like arrangement of coarse, long, distally bifurcate spines which originate on the dorsal body region. Basal plates are indistinct or wanting. Its closest relative is *C. succinctus* Voigt (2) which, while possessing a similar arrangement of spines, has only nine of them, and all taper to a point; otherwise, the two species are, on the basis of available descriptions, remarkably similar.

On August 11, 1958, a gastrotrich was recovered from the soft detritus off the bottom of a small spring-fed pool called Lake Rana at the Mountain Lake Biological Station of the University of Virginia, Giles County, Virginia. The animal was mounted in methocel under a supported cover slip and remained alive for several hours during which time it was observed in several positions.

This specimen had a broad, 5-lobed head, the posterior pair being clear and vesicular, a condition described by early workers as "eyes" but without verification as to sight. There was a prominent cephalic shield and a clearly defined esophageal (pharyngeal) swelling or bulb at the intestinal junction. The intestine was coarsely granular. The organism as a whole had the regular Chaetonotid form of head, narrower neck, and slightly enlarged body, the total effect being that of a slender milk bottle with spreading "toes."

Between the posterior furcae there was a short pair of thorns surrounding a central one. Lateral to the furcal appendages was an extremely long pair of spines. Anteriorly to these, extending laterally, was a lesser spine pair about half the length of the longer laterals. Measurements taken were:

Total animal length	196.47 m μ
Shield length	18.31 m μ
Esophageal length	43.29 m μ
Furcal length	19.98 m μ
Posterior spine length	36.63 m μ

* This study, made possible by a grant from the National Science Foundation, was carried out under the supervision of Dr. Horton H. Hobbs, then director of the station, whose interest and assistance are gratefully acknowledged.

Head width	19.98 m μ
Neck width	19.98 m μ
Body width	39.96 m μ

Of particular interest, however, was the presence dorsally of a row of long spines with delicately notched tips. Once eight spines were counted; in another view, 12 seemed to be present, but this was not positive due to their slimness and crowding. They did not seem to be imbedded in an exact alignment. Interestingly they were capable of elevation and depression as is the case with *Stylochaeta*'s cuticular extensions. The body edge presented a peculiar incised appearance, noted many times in other gastrotrichs studied, especially *Lepidodermella*. Laterally also, under certain light conditions, sharply pointed, wavelike, curved and raised elevations or thickenings evidenced a kind of possible scalation, a uniform Chaetonotid feature.

The water temperature of Lake Rana was recorded at 3 p.m. as 24.5° C. This small pool was artificially created, had an inflow and outflow of cool water. Samples of the soft sediment showed a variety of microscopic organisms but never contained at any time gastrotrichs in quantity, nor did any other water source in the immediate vicinity of the laboratory. Many samples from the same pool were gathered in the summer of 1960 but all attempts to locate either *C. succinctus* or *C. bisacer* failed. Greuter found his specimens in January, February, and March, later in August.

Remane's authentic and extensive work (3) mentions *C. bisacer* briefly, placing it with *C. succinctus* in the subgenus *Zonochaeta*. It would appear that, for the second time, an observer has found the former species. It is herewith recorded as a highly probable member of the gastrotrichan fauna of the United States.

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Poisonous Plants

Plants are such a familiar part of our environment that most of us take them for granted. Yet, they play a more important role in our lives than most of us realize. Plants not only regenerate the oxygen vitally necessary to man and the other animals for releasing the energy locked in their food, but they also are the ultimate source of that food. Plants are unique among living organisms in their ability to transform the radiant energy of the sun into chemical energy (food) through the process of photosynthesis. In the United States, plants contribute directly from six-tenths to two-thirds of the total of our diet. In many of the other countries, plant sources directly account for an even larger share of the diet—from 85 to 100 per cent. In addition to furnishing the bulk of man's food, plants further provide for many of our other needs, such as for fiber, fuel, and shelter. By trial and error, man also has learned that some plants can be used as medicines to cure his illness; that particular plants when placed in a pond will stun fish, and that juices from others made his arrows more effective, thereby making it easier for him to gather his food; and, finally, that some plants are poisonous and therefore to be avoided. Within the limitations of available space, this last aspect will form our topic in the paragraphs to follow.

The present generation of Americans shows a preference for living in the suburbs and possesses a strong inclination to travel. Each of these characteristics increases the individual's chance of coming into contact with some of the poisonous plants found in the environment. Accordingly, poisonous plants are a potential hazard to an increasing number of Americans, and particularly to children whose curiosity may be aroused and their palate tempted by the sight of attractive berries, fruits, roots, and other plant parts. Parents and teachers can help children to protect themselves by teaching them a) to recognize the poisonous species and b) to follow a few practical rules. We will enumerate a few of the plants most likely to cause trouble and conclude with a short list of suggestions to reduce the risks.

Let us begin by asking how we define a poisonous plant? The definition differs only slightly from the definition of the general term "poison" (1) —viz., any plant containing one or more substances which,

when ingested in relatively small quantities, can cause death or illness in living organisms by chemical action. The terminal qualifying phrase of the definition eliminates such things as wooden arrows or projectiles from the classification. In most poisonous plants, all parts of the plant are toxic, but in some, different parts may vary greatly in the degree of toxicity. To illustrate, fruit may be more, or less, toxic than the leaves or roots. Any permutation may prevail in a specific instance. In general, if one part of a plant is known to be toxic, it would be wise to avoid all other parts of that plant unless one is absolutely certain that the given part is wholesome. The common potato provides an example. We eat the tubers, but the vines, sprouts, or green peelings from the tubers are poisonous and have caused human deaths (2). The degree of toxicity also may vary with the season of the year or the stage of development of the plant. It may be further influenced by the character of the soil in which the plant grows and upon general climatic factors.

Poisonous plants are not necessarily confined to the wild, open areas. They may be found as ornamentals in the house, or as vegetables, flowers, shrubs, or trees in the garden and borders around the home. In the wild, they may occur along roadsides and streams, in meadows, fields, and woods.

Let us enumerate some that may be found indoors; i.e., in the house, offices, lobbies of public buildings, etc. Current tastes in interior decoration emphasize the foliage plants. Among these, plants of the arum family play a prominent part. Members of this family usually contain needle-like crystals of calcium oxalate. If parts of the plant are taken into the mouth and chewed, the crystals penetrate the tissues causing severe irritation and swelling. Breathing may be seriously restricted or even blocked. The so-called *philodendrons*, undoubtedly the most common house plants in the United States, are members of this family. Others are: the brilliantly colored, or fancy-leaved *caladiums*; the *dumbcane* with its large oblong leaves, frequently variegated; the *elephant's ear* with its gigantic, usually light-green leaves borne on long stalks.

The *poinsettia* and the *Jerusalem Cherry*, both symbolic of Christmas, become widely displayed indoors at that season. Both are poisonous. The former belongs to the spurge family, a group characterized

by a viscous exudate when the plant is bruised. In the *poinsettia*, the exudate is milky as it is in most spurge, but in some, it may be clear, as in the *castor bean* or in the *crotos*. *Poinsettia* is toxic in all its parts, fresh or dried. Temporary blindness may result if the juice is transferred to the eyes.

The *Jerusalem Cherry* is not a true cherry, but like the potato and tomato, belongs to the nightshade family. The bright, orange-red berries, resembling small tomatoes but less fleshy, are very ornamental, and may be tempting to small children. The berries are reputed to be toxic (2), hence the plant should be placed where small children cannot reach it.

The berries of the *mistletoe*, another popular plant of the Christmas season, have caused fatalities in children (3).

The home grounds may harbor a number of other poisonous species. Among the herbaceous types, grown mainly for their attractive flowers, we may mention the following familiar plants: *hyacinth*, *daffodil*, *lily-of-the-valley*, *monkshood*, *iris*, *foxglove*, and *lantana* (particularly the black, berry-like fruits).

The shrubs and vines used for landscaping purposes around the home also are represented by poisonous types. These include various *privets*, common hedge plants (2, p. 262); the *yews*, evergreens whose leaves, bark, and seed (surrounded by a bright red, fleshy cup) contain a deadly alkaloid; *mountain laurel*, poisonous in all its parts; the seeds and pods of the *wisteria* vine; the blue-black berries of *English ivy*, widely used to cover masonry walls and fences and as a ground cover on steep slopes; the berries of *holly*, *skimmia* and *daphne*. The leaves of *cherry laurel*, a common ornamental shrub in Virginia, contain glycosides which liberate deadly cyanide when bruised or ingested.

The *castor bean*, although not a shrub, is frequently grown locally in the border for bold foliage effects. This plant is poisonous in all its parts. The attractively marbled seeds, the source of castor oil, may be tempting to children. As few as two can produce severe symptoms and six to eight may be fatal to a child.

In the milder parts of Virginia, the *oleander* may be grown as an outdoor shrub. All parts are toxic, a single leaf is considered fatal for a human being. The toxic principle acts on the heart, and severe poisoning of a number of people is recorded (2, p. 265) from eating roasted frankfurters which had been skewered on *oleander* stems.

The countryside presents its own perils. There, also, a number of poisonous plants may be encountered. Again, those with conspicuous or berry-like fruit are most likely to be potentially dangerous. Among the herbaceous types the following may be listed and children should be cautioned against eating them: the *black nightshade* (berry black); the *climbing nightshade* (berry red); the *horse* or *bull nettle* (berry yellow). All three of the preceding bear fruits resembling those of a small tomato. The *Jimson weed* or *thorn apple*, another member of the nightshade family, is common in the fields and

along roadsides or fencerows. A poisonous alkaloid is present throughout the plant, but the spiny capsules are the most troublesome because children mistake them for edible fruits, and within are the seeds which are especially toxic.

The *pokeweed*, also known as *pigeonberry*, is widely distributed in the eastern United States. While there is no doubt about the toxicity of the root, there is some question about the toxicity of the berries which are more likely to be consumed by humans. The safest course would be to regard the fruits with suspicion until we have proof to the contrary.

The various wild cherries, known also as the *choke cherry*, the *black cherry*, and the *pin cherry*, like the *cherry laurel* contain bound cyanide which is liberated when the leaves, twigs, bark, and seeds are bruised or ingested. Fortunately, in these the most attractive part, the pulp of the ripe fruit, is the least toxic.

Any discussion of poisonous plants must include the "hemlocks"—the *water hemlock* and the *poison hemlock*. Both belong to the carrot family, but contain different poisonous principles. The *water hemlock*, as the name implies, grows mainly in wet places along streams, springs, or in swampy areas. This plant, with leaves somewhat resembling those of celery, contains a violent convulsant. The cluster of fleshy roots is most likely to tempt the curious (2, p. 378). A single mouthful can be fatal to a human.

The *poison hemlock*, a near relative of the preceding species, can grow in somewhat drier situations. The leaves of the *poison hemlock* appear to be more feathery than those of the *water hemlock*, and instead of the clump of roots characteristic of the latter, the *poison hemlock* has a single long taproot. Owing to the fern-like leaves, the plant sometimes has been referred to as *California fern*. The cup of poison which Socrates was compelled to drink contained an extract from this species. Poisonings from this plant occur when the root is mistaken for edible parsley or when the seeds are used as a condiment. The odor emanating from the plant, especially when bruised, is characteristically mousey.

The list of poisonous plants could easily be extended. The VPI bulletin (4) prepared by Professor A. B. Massey describes a much more extensive list. In the present article, attention was focused on those plants most likely to cause trouble for humans and particularly children. It is intended to alert teachers to the possibility of acquainting their students with the potential hazards posed by some of the plants found in their environment.

Preventive Rules

The following simple rules, if impressed on youngsters and if followed, would greatly reduce the risks of poisonings from toxic plants:

1. Learn to recognize the potentially dangerous plants around your home and your locality (2, 3, 4).

2. Keep infants and small children away from poisonous berries and mushrooms, or vice versa. These two classes account for the greatest part of the poisonings by plants.
3. Don't experiment! Never put any part of an unknown plant into your mouth.
4. If there is any question about the identity or wholesomeness of any mushroom, *do not eat it*. There are no reliable simple tests, applicable at home, which tell whether a mushroom is poisonous or not.
5. One cannot conclude that a plant or plant part is safe for humans just because other animals are seen to eat it. Deer eat yew; cows and humans have been poisoned by it.
6. Cooking does not always destroy or remove the poisonous principle.

If ingestion of a poisonous plant does occur, the victim should be taken to a physician for prompt emergency treatment. The treatment can be most effective only if the nature of the plant or poison is known, therefore, it is important to obtain a good sample of the plant for identification. The patient can then be treated specifically.

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TEACHERS! !

Do you have a question that you'd like answered?

Do you have a favorite demonstration, method of getting across a concept, or an experiment that you'd like to share with others?

Do you have a technical article that you'd like to have published?

Are you involved in a program, a course of study, or an activity which you think would be of interest to other educators?

Would you like to analyze or give a critical evaluation of a curriculum, talk, article, or book?

Would you like to do a little philosophizing?

GREAT NEWS—NOW IS YOUR CHANCE!!

The editor of the Virginia Journal of Science plans to devote a page or two in each issue to items written especially for junior and senior high school teachers of science and mathematics. We are now soliciting contributions which will be of interest to teachers and which will be of value in furthering scientific and mathematical education in the state.

Send your contributions to Virginia C. Ellett, Mathematics and Science Center, 2200 Mountain Road, Glen Allen, Virginia 23060. Do this right away so that they may appear in the next issue of the Journal, but don't stop here. Let this be the beginning of many articles from you. Remember this is YOUR section and its success depends upon your contributions.

Communications and Reports

VIRGINIA ACADEMY OF SCIENCE

Summary of Council Meeting*

October 25, 1969

Council met on Saturday, October 25, 1969 at Washington and Lee University, Lexington, President Carpenter presiding.

Reports of Officers

President Carpenter announced that Past-President Paul Siegel had been appointed officially as Science Advisor to the Governor, and that efforts were now under way to have the science advisor appointed to membership on the state's Research and Development Advisory Committee. Appointments of Messrs. Frank F. Flint and John L. Perry to the VJAS committee, to fill vacancies occasioned by the resignations of Messrs. Leftwich and Davenport, and of Paul Siegel to the Finance Committee to replace Foley Smith were reported. President Carpenter represented the Academy in the sesquicentennial celebration of the University of Virginia. He has invited Dr. Robert M. Wood, Deputy Director of Research and Development, MacDonald Douglas Astronautics Company, as the Sidney S. Negus Memorial Lecturer for 1970.

Austin Grigg submitted the Treasurer's report for the third quarter, ending September 30, 1969.

Rodney Berry, Executive Secretary-Treasurer began his report by circulating a photograph of President-Elect Rowe making a presentation of the Academy's book "The James River Basin" to Governor Godwin. He reported that the Academy had received \$8,000 from the Foley F. Smith estate. This money has been deposited in a savings account and is drawing 5 1/4% interest. He moved that the \$420 dividend income on this investment be used for general purpose, and Council approved the motion. His request for authorization to print the membership list in a booklet form separate from the Journal was approved. He announced that \$2,000 had been received from the National Science Foundation and had been deposited for use by the Virginia Junior Academy of Science.

Attention was called to an error in the minutes of the Executive Committee's meeting of September 16, 1969. The \$500 donation to the VJAS was made by Reynolds Metals Corp.

Visiting Scientists Program

President Carpenter reviewed the Academy's Visiting Scientists Program in the state high schools. This year, 399 scientists, and 27 colleges have agreed to participate. This compared to 237 scientists and 22 colleges last year.

Long Range Planning Committee

Alex Clarke presented the report of the Long Range Planning Committee. In a discussion of the first item (Annual Meeting), it was brought out that sites for the annual meeting of the Academy are, constitutionally, recommended by the Executive Committee and approved by the membership. Council accepted item 1 of the report as being of an advisory nature to the president.

In a discussion of item 2 (Continuity of Committees), it was suggested that each committee consist of 3 classes, with 1/3 of the committee membership rotating off each year. President Carpenter called attention to the list of duties of officers and committees which had been circulated recently. Mr. Midyette said that in the proposed revision of the by-laws, each president will appoint 1/3 of each committee and select the chairman, and that Council will establish the duties of committees.

Item 3 (Advancement and improvement of the teaching of pre-college level science in this state) was discussed extensively. In response to the proposal that a committee should be established to aid in the evaluation and selections of texts in science and mathematics, it was asked whether the report proposed a committee distributed geographically over the state. Mr. Clarke stated the distribution should be by field of competence and age group to be served. The Committee would review texts and make the reviews and recommendations available to the proper authorities. Mr. Harlow pointed out that the Virginia State Board of Education (VSBE) has welcomed cooperation for years, having asked certain members of the Academy to review texts. He suggested that the VSBE be approached to find out if they would like additional assistance. Vera Remsburg said the VSBE offers a selection of approved texts which allows diversity. Mr. Harshbarger suggested that the president contact Mr. Franklin Kizer and the VSBE and offer the assistance of the Academy. Mr. Brooks amended the suggestion to say that the Academy is "concerned" and offer assistance. President Carpenter said he would talk with Mr. Kizer and make this an item on the agenda of the next Council meeting.

Local Arrangements Committee

President-elect Maurice Rowe announced that Dr. Tom Marlowe had been selected chairman of the Local Arrangements Committee for 1971. He reported that the present committee is working extremely well, and that their arrangements were well ahead of the schedule of plans. Arthur W. Burke, Jr., expressed his appreciation for the cooperation and assistance of Mary Kapp of Virginia Commonwealth University and Addison Campbell of the University of Richmond.

* Abbreviated by the Editor from minutes provided by the Secretary, Edward F. Turner, Jr.

Mr. Campbell asked for advice regarding the planning of the banquet. After considerable discussion, Mr. Midyette moved that Council reaffirm the motion of May 10, it being the sense of this motion that details of the dinner be left to the Executive Committee. Motion passed.

President-elect Rowe announced that call for papers for the Annual meeting would go out in early January. It was essential to establish a deadline for receipt of titles. The program must be complete for printing 2 to 3 weeks prior to meeting.

Mr. Clarke asked if papers would be moved from one section to another. Mr. Rowe said that this should be worked out between the chairmen and secretaries of the sections involved.

Publications Committee

Although there was no report of the Publications Committee or the Flora Committee, President Carpenter reviewed for Council correspondence with Dr. Harvill relating to the proposed publication on Virginia Flora. Dr. Harvill has indicated that no funding was requested at this time and that his Committee would come to Council through the Publications Committee in several years for specific publication funding at which time they would be able to provide the necessary details to permit a Council decision. He was advised by Dr. Carpenter that sufficient advance notice of this request was necessary to allow for inclusion in the annual budget of such funding as Council approves.

Museum of Science Committee

There was no formal report of the ad hoc committee on the Museum of Science. Mr. Midyette asked what role the ad hoc committee should play in rallying support for the Museum of Science Commission report. President Carpenter said, in view of the fact that Council had not seen the report and consequently had not been able to take a position on it for the Academy, the committee could not act as an agent of the Academy, but individuals were free to act in their own behalf.

Mr. Harlow moved: "The Academy endorses the concept of the Museum of Science and supports the recommendations in the minutes of the Executive Committee of September 16, 1969 except with respect to the critique, and directs the Executive Committee to proceed." Motion passed with Mr. Bradley dissenting.

Ad Hoc Committee on Executive Officers

President Carpenter reviewed the report presented to Council at its meeting May 8, and the actions of the Executive Committee with respect to that report. He distributed copies of the minutes of a telephone conference of the Executive Committee held on October 15, 1969. Mr. Harshbarger moved that the 4 recommendations of the Executive Committee with regard to the Executive Secretary-Treasurer and the Director of Academy Development, outlined in the minutes of the telephone conference of October 15, be approved. He added, in support of his motion, that the funds re-

quired by these recommendations had been incorporated in the proposed budget. Motion passed. Mr. Brooks suggested that consideration be given to compensating the American Tobacco Company for any use of its computer services that would be implemented under the proposed changes.

Finance Committee

Mr. Harshbarger distributed copies of the report of the finance committee. He called attention to the rate increase for registration from \$2 to \$3 for members, and from \$3.50 to \$5, for non-members. Council approved the report of the finance committee, including the budget. Mr. Midyette moved that non-commercial exhibitors be charged and the number of such exhibitors be left to the discretion of the Local Arrangements Committee. Council approved the motion.

Proposed Botany Section

Mr. Stuart Ware reviewed events leading to the growth of interest in a botany section, and cited a number of letters supporting establishment of such a section. He said that a botany section would attract support from some who are not now members of the Academy, particularly from among a number of botanists who have recently come into the state. Mr. Bradley inquired about the response of the Biology and Agriculture Sections to the proposal. President Carpenter cited the report of the ad hoc Committee on Reconstructing the Life Sciences Sections. Mr. Brooks suggested that consideration should be given to renaming the Biology section after the 3-year probationary period, and that members of the Biology section had no strong objections to the proposed Botany section.

Mr. Harshbarger stated that Council should support any section that demonstrates dynamic leadership and moved the following: "That Council authorize the formation of a Botany Section for the purpose of presenting a program at the May, 1970 meeting, leading to the formal establishment of a Botany Section of the Academy." Vera Remsburg asked if the new section was eligible to elect a representative to Council. President Carpenter ruled that they were not until after the May, 1970 meeting. Council approved Mr. Harshbarger's motion.

Fellows

It was the sense of Council that adequate notice had not been given all members for submission of nominations. Discussion of several motions resulted in final action being taken to issue an invitation to all members for nominations and requiring that nominations be sent to the Awards Committee by March 1, 1970.

Miscellaneous Actions

Mr. Siegel moved that the money received from the Foley Smith estate be set aside and designated the Foley F. Smith Fund. Motion carried.

Mr. Berry recommended, and Mr. Harshbarger moved, that copies of the book "Early Virginia"

be put on sale at a price of \$3 by the Academy at its May, 1970 meeting. Motion carried.

Mr. Siegel moved that permission be granted to the Executive Secretary-Treasurer to write institutional members to remind them that they receive copies of the Virginia Journal of Science as part of their membership and that they are not expected to purchase additional copies for their library collections. Motion carried.

Mr. Berry requested permission to drop from the printed roll of members, those who have not paid their dues by December 15. Mr. Midyette proposed and Mr. Bradley moved that this be done, but that a last plea for membership accompany a notice that a member's name would be dropped.

Introduction to Plastics

By J. H. BRISTON AND C. C. GOSSELIN
Philosophical Library Inc.
New York, 1968
147 pages

This is a useful and well named book. It is about polymeric solids, perhaps the most ubiquitous class of solids. However, it is unlikely that the typical solid state physicist will feel much compulsion to read this book unless he somehow actually gets into the 2nd or 3rd chapter. There, his natural curiosity about his immediate environment might induce him to continue reading. Although the book cannot be described as a rigorous presentation of the physical or chemical principles of polymeric solids, one of its most outstanding features is the quantity and diversity of information contained in its relatively short length (147 pages but there are about 20 pages with no text). After a short introduction, the book is divided into three sections: I. Materials (thermosets, thermoplastics, natural polymers); II. Processing Plastics; and III. Applications (in buildings, transportation, packaging, home use, future). There is also a detailed table that outlines almost thirty simple tests for the tentative identification of most of the common plastics. Other clues for recognizing various polymers are in Section I.

The authors are involved in plastics technology in Great Britain and many of their examples are drawn from experience in that country. Their British background also shows in numerous amusing terms; e.g. screw closures (for bottle caps), auto tyres, washing-up-bowls, and gramophone records.

In addition to outlines of the physical characteristics and of the chemical processes associated with a large number of important polymers the book contains a potpourri of miscellaneous information about applications. For example, the bakery industry uses silicone resins to coat bread-tins and reportedly gets hundreds of releases per application. "Other, minor, uses include vial stoppers, gaskets, heart valves and teats."

Many items of historical interest appear in the book; e.g. Regnault reported in 1838 (almost a century before the polymer hypothesis was fully

accepted) that when vinyl chloride gas was exposed to sunlight, a white film formed. As another example, shellac, a natural polymer derived from the lac bug of Burma and India, was mentioned by Marco Polo in the 13th century.

Plastics processing is discussed in enough detail to be of technological usefulness in a qualitative way. Many drawings and photographs of machines are shown and their main parts are defined and their functions outlined. For example, one is told about vacuum forming, pressure forming, matched mould forming, drape forming, and plug-assist forming.

The book also contains passages that may be classified under psychology and/or economics. In these categories are discussions of the prevalent (but gradually vanishing) false idea that plastics are usually cheap substitutes; black milk cartons covered with white to improve sales appeal; differing social patterns that lead to quite different designs for cigarette packs in America and England; and the fact that it is not the price per unit mass that makes plastics economical for engineering applications—it is the total savings to produce a finished item.

The book has a satisfactory index and should be helpful to engineers and others who wish to get an idea about the wide range of uses of plastics, their properties, and methods of processing.

—R. E. BARKER, JR.

Spring Flora of Virginia

A. M. HARVILL, JR.
McClain Press.
\$8.50 + 34¢ tax.

Approximately 265 pages, with historical introduction, frontispiece from Mark Catesby, 120 plant illustrations, 70 illustrated terms, map, glossary, keys to families through species, ecology, Virginia distribution and over-all distribution of each species, index to scientific and common names, bound in buckram.

This book will be useful for amateur and professional botanists, students, teachers, foresters, horticulturists, wildlife and conservation researchers, county agents, libraries, and all those interested in the natural history of Virginia and its neighboring states.

Order from: Spring Flora of Virginia, Darlington Heights, Virginia. 23935.

BANQUET REINSTITUTED FOR 1970 MEETING

After a lapse of nearly twenty years, the annual Academy meeting included a banquet on Thursday evening, May 7, at the John Marshall Hotel in Richmond. The Council, in approving this addition, hopes it will enhance the opportunities for fellowship and personal contact among our members in various disciplines. All Academy members are encouraged to communicate to any member of Council their wishes about future banquets.

News and Notes

1970 SIDNEY S. NEGUS MEMORIAL LECTURE

The Sidney S. Negus Lecture will be given by Dr. Robert M. Wood, Deputy Director of Research and Development, MacDonald Douglas Astronautics Company. Dr. Wood will talk on the "Giant Discoveries of Future Science," following the banquet on Thursday evening, May, 7, 1970. He will probably touch on extrasensory perception, teleportation principles, unidentified flying objects and other ideas as yet unconfirmed on a scientific basis. He is an engineer by vocation and a physicist by training. This is the first time in about thirty years that our principal speaker has been an engineer.

GEOLOGY SECTION PROGRAM

At the annual meeting in May the geology section will present a series of papers dealing with the uses of geology, especially as applied to Virginia. Representatives of State, Federal, academic and industrial groups are being contacted to present and explain their vocation. Research papers both by professionals and students are being solicited. Applicable movies are scheduled. The theme of this meeting will be to introduce the many types of employers using geologists. All people interested in the uses of geology in the Commonwealth are invited to attend.

GEOLOGICAL FIELD CONFERENCE HELD

Ninety-three geologists and geology students participated in the first annual Virginia Geological Field Conference held in Williamsburg, Virginia on September 27-28, 1969. The Conference, sponsored by the Geology Section, Virginia Academy of Science and the Department of Geology of The College of William and Mary, centered upon two days of field trips during which the participants studied the geology of the York-James Peninsula and the south bank of the James River. On the evening of the 27th a brief summary of the local geology was presented. This was followed by an informal smoker which allowed the participants to become better acquainted and to discuss matters both geological and otherwise.

The participants were drawn from all segments of geological endeavor and the Field Conference leaders were pleasantly encouraged by the broad and enthusiastic support they received from their fellow geologists. Most of the Colleges and Universities in Virginia were represented by their geology faculty and students. Participants also came from several State and Federal agencies including The Virginia Division of Mineral Resources, The United States Geological Survey, The National Park Service, The United States Army Corps of

Engineers, The Virginia Department of Highways, The Virginia State Department of Education, and The Virginia Division of Water Resources. Several Earth Science teachers from both public and private schools also participated. Particularly rewarding was the support given by geologists employed in industrial phases of geology. Geologists from numerous companies attended and this all too infrequent opportunity for the free interchange of ideas between academic and industrial geologists was one of the strongest contributions of the Conference. There is something special about a field trip which induces geologists to communicate readily and which builds a companionship much more easily than any other type of meeting. The longest journey was undertaken by a group of geology students and a faculty member from Marietta College in Ohio who attended the Field Conference.

The weather cooperated nicely in allowing both day's trips to be conducted in cool but clear conditions. On the first day the group studied the Miocene and Pleistocene geology of the York-James Peninsula. Participants examined the type Yorktown Formation and changes in the physical- and biostratigraphy of the Yorktown to the east and west of the type area. Pleistocene estuarine and littoral deposits and morphological features on the Peninsula were also studied. The second day concentrated on the south bank of the James River where the physical stratigraphy was compared with that of the Peninsula. The field trips were very ably led by Gerald Johnson of the Department of Geology, College of William and Mary, and his cheerful and enthusiastic presentation did much to make the Conference a success. He also prepared an illustrated Guidebook describing the geology and containing a detailed road log for the trips. Unfortunately the manuscript was detained in the hands of the printers and the Guidebook was published after the Field Conference. However, an emergency, abbreviated Guidebook was produced for the Conference and the participants accepted this minor difficulty with good grace.

The Virginia Geological Field Conference was conceived by the Geology Section of the Virginia Academy of Science. For several years, members of this Section have suggested that such a Field Conference be established. Similar conferences had been held with great success for many years in New England, Pennsylvania, New York, and the Carolinas. The conference was to serve the dual purposes of familiarizing Virginia geologists with the geology of various areas within the Commonwealth and providing a means whereby all the geologists in Virginia could get together annually and discuss geology in an informal manner. The Field Conference was intended to supplement the annual meeting of the Virginia Academy of Science

and to strengthen the activities of the Geology Section of the Academy.

At the last Spring meeting of the Academy, the Geology Section voted to initiate a Geological Field Conference in Virginia and appointed Bruce Goodwin of the Department of Geology, College of William and Mary to organize the first year's activities. This was accomplished as outlined above in this note. It appears the Virginia Geological Field Conference is in fact destined to become an annual event and hopefully the number of participants will increase each year. Invitations have already been extended for the next two years. In the fall of 1970 the Conference will be held at Washington and Lee University and in 1971 the University of Virginia will be host.

BRUCE K. GOODWIN

MCV HEAD APPOINTED

Dr. Warren W. Brandt, president of Virginia Commonwealth University, has announced the appointment of Dr. Lauren Albert Woods, nationally noted scientist and educator, as Vice President for Health Sciences. Dr. Woods, currently professor and head of the department of pharmacology at the University of Iowa, is expected to assume his duties at the Medical College of Virginia, the Health Sciences Division of VCU in Richmond about July 1, 1970. Dr. Woods has a Ph.D. degree in organic chemistry from Iowa State University and an M.D. degree from the University of Michigan. He has been professor and chairman of pharmacology at the University of Iowa since 1960. He formerly was a member of the faculty at the University of Michigan for 15 years, rising from research fellow in pharmacology and instructor to acting chairman and professor of pharmacology. A native of Letcher, S. D., he received his B.A., cum laude, from Dakota Wesleyan University in Mitchell, S. Dakota in 1939.

Dr. Woods brings a background of outstanding experience to the position of chief academic officer of the Health Sciences Division. He is president-elect of the American Society for Pharmacology and Experimental Therapeutics and president-designate of the Federation of American Societies for Experimental Biology. He currently is a member of the American Medical Association's Council on Drugs, chairman of the advisory committee to the drug standards committee of the American Pharmaceutical Association, and a member of the Pharmacology-Toxicology Review Committee. He is former chairman of the committee for the examination of pharmacology of the National Board of Medical Examiners and former acting chairman of the cancer chemotherapy study section, National Institutes of Health. He is a former member of the editorial board of the Journal of Pharmacology and Experimental Therapeutics and a former associate editor of Medicinal Chemistry.

Dr. Woods is a member of Sigma Xi, Alpha Omega Alpha, the American Chemical Society, the American Association for the Advancement of Science and the New York Academy of Science.

MCV EXPANDS SANGER HALL AND LIBRARY

The Department of Health, Education, and Welfare has awarded more than \$7.6 million in federal funds for two major construction projects at the Medical College of Virginia, the Health Sciences Division of Virginia Commonwealth University in Richmond.

The grants provide \$6,354,002 for construction of a 15-story addition to Sanger Hall and \$1,294,720 for expansion and modernization of the Tompkins-McCaw Library. This represents almost a two-to-one match of federal funds to state funds. The state has appropriated about \$3.3 million from general obligation bonds for the Sanger Hall addition and approximately \$705,000 in state funds for the library project.

Construction on the Sanger Hall addition, which will extend the building from East Marshall to Broad Street between 11th and 12th Streets in downtown Richmond, is slated to begin early in 1971 with completion set for January 1973. Sanger Hall, the medical education building, was named in honor of Dr. William T. Sanger, MCV's third president, now chancellor emeritus. Dr. Sanger was President of the Virginia Academy of Science, 1934-35 and was presented its meritorious service award in 1956.

The 15-story addition will mark the third stage of construction on Sanger Hall. The first 10 floors were completed and occupied in 1963 and provided space for administrative offices of the Health Sciences Division and laboratories and teaching areas for the departments of medicine, surgery, biophysics, and pathology with minimum facilities for several other departments. The second stage of construction, which is being completed this spring, has added three new floors to the east wing and two new floors to the south wing with primary space provisions for the departments of obstetrics and gynecology and pediatrics. The upcoming 15-story addition, which will have 12 floors above ground and three below, will provide space for the departments of anatomy, biochemistry, microbiology, physiology, radiology, and additional space for medical subspecialties.

Construction on the Tompkins-McCaw Library at the Health Sciences Center will enable modernization of the present 38-year-old library and construction of an addition that will triple the library's present size. The library's current 18 thousand square feet of space will increase to 59 thousand square feet when construction is completed in early 1973.

The present Colonial architecture of the Tompkins-McCaw Library will be continued for the new three-story structure on North 12th Street. The new building, with two floors above ground and one below, will have one floor each devoted to journals and reading-conference rooms; administrative offices, reference materials, and public service facilities; and bound volumes and study rooms. The present library houses more than 100,000 bound

volumes, journal subscriptions numbering more than 2,000, the Simon Baruch Collection and other material of historical interest to MCV, and a small museum collection of medical instruments and material from the Civil War period. The new addition will provide badly needed reader areas, and space for increased library services and collections.

SPACE RESEARCH ASSOCIATION

Dr. A. Robert Kuhlthau, professor of aerospace engineering and associate provost for research at the University of Virginia, has been appointed acting president of the Universities Space Research Association (USRA). The Universities Space Research Association, with headquarters in Washington, is a national consortium of 48 universities founded to foster co-operation between universities, the federal government and other space-oriented organizations for the advancement of space research. USRA expects to operate laboratories and other facilities for research, development and education associated with space science and technology. As its first activity the consortium has assumed responsibility for operation of the Lunar Science Institute in Houston, Texas, under a contract with the National Aeronautics and Space Administration. The institute is located adjacent to NASA's Manned Spacecraft Center and has the prime objective of providing a base for university scientists involved in lunar studies where access to the results of the Apollo program is vital. The institute will also serve as a center for analysis and study of lunar data obtained as the result of other NASA missions. The scientific facilities of the Manned Spacecraft Center, including the Lunar Receiving Laboratory, will be available on a co-operative basis for institute scientists to use for their research.

Dr. Kuhlthau received his graduate training in physics at the University of Virginia and has been associated with the department of aerospace engineering and engineering physics there since its inception during the early 1960's. Before assuming his present administrative post at the University, he served as director of the Research Laboratories for the Engineering Sciences and as associate dean of the School of Engineering and Applied Science. Although Dr. Kuhlthau plans to relinquish his teaching duties, he will continue as associate provost for research and maintain some of his research activities at the University. The trustees of USRA expressed deep indebtedness to both Dr. Kuhlthau and the University of Virginia for making the necessary arrangements to enable Dr. Kuhlthau to serve the consortium on this temporary basis during the present academic year.

SUMMER SCIENCE INSTITUTE OFFERS DEGREE PROGRAM

The first session in a three-year summer program which may lead to a masters degree in science teaching, will open in June at Randolph-Macon Woman's College, Lynchburg, Virginia.

The graduate degree program, the first offered by the College in more than 30 years, will be built

around the Summer Science Institutes for Secondary School Teachers which have been held previously at Randolph-Macon under the sponsorship of the National Science Foundation. Dr. Helen L. Whidden, professor of chemistry, is director of the institute. The College has been awarded a grant of \$74,022 by the NSF to support the 1970 Summer Institute in Science and Mathematics. The institute will be similar to the previous eleven held at Randolph-Macon except that it will be the first of a three-year summer sequential program, will last eight instead of six weeks, and for qualified applicants may lead to the degree of Master of Science Teaching.

Randolph-Macon Woman's College has not offered a graduate degree since it discontinued its master of arts program in 1936. The College's science and mathematics departments planned the new program and recently won approval of the faculty for awarding the Master of Science Teaching.

Dr. Whidden describes this summer's institute as a multiple-field program with courses in biology, chemistry, physics, and mathematics. It will run from June 22 to August 14 and is open to both men and women teachers of secondary school science subjects or mathematics.

The courses have been designed at a graduate level especially for the institute. Different courses in the four disciplines and seminars to enrich the program have been planned for each of the next three years. Twenty-four credits plus a thesis will round out the degree program.

PSYCHOLOGY RESEARCH AT HOLLINS COLLEGE

Recent grants totaling \$57,786 bring to over one million dollars the federal research funds awarded to the Hollins College psychology department since 1959, according to Dr. Ronald L. Webster, department chairman.

The funds have supported departmental research on brain and muscle processes that accompany speech and thinking activities, language development studies in infants, and stuttering, and a number of basic research projects dealing with the properties of motivation and learning. In addition, student research has been supported by National Science Foundation Undergraduate Research Participation grants to the department.

Dr. F. J. McGuigan, a member of the department since 1955, has focused his research on the brain and muscle processes that occur when people are involved in different types of thinking activities. He has written five books in his field, including *Experimental Psychology*, a widely used text first published in 1960 with a new edition in 1968.

Dr. Webster's research on language development is concerned with the question of how the sounds and words heard by infants influence the development of language. He also is working on the establishment of procedures to aid stutters in acquiring fluent speech. Results of research conducted in the

Hollins laboratories suggest that approximately 8 out of 10 stutterers can be taught to speak with markedly improved fluency.

The results of Dr. Paul Woods' basic research in learning, dealing with the scaling of aversive stimuli and with the major variables involved in instrumental escape conditioning, have appeared in numerous articles in the professional literature. He is currently a consultant to the Federal Reformatory for Women in Alderson, West Virginia and chairman of the Board of Trustees of the College Research Center.

BIG G

A device which will help to clarify a two-and-a-half-century old scientific puzzle has been developed at the University of Virginia. Conceived by Dr. Jesse W. Beams, professor emeritus of physics and National Medal of Science recipient, the device is being used to pin down the exact value of the gravitational constant.

In the 18th century, Sir Isaac Newton first described the gravitational forces with which every particle in the universe attracts every other particle dependent on the mass of each and the distance between them. His mathematical formula for this force contains a quantity which he called "G" and which he supposed never changed. Because the gravitational force is so weak, scientists have been able to measure G to only one part in 500. Now University of Virginia researchers, headed by Dr. Beams, hope to refine the measurement to one part in 100,000.

The gravitational constant is the most fundamental constant in nature, yet it is the least precisely known. It enters into all cosmological theories and because of the recent emphasis on space travel, it seemed desirable to increase our knowledge of G. A more precise knowledge of G would, for example, enable scientists to better calculate the density of the earth, as well as the other planets.

The new device surmounts some of the obstacles which kept other methods of measurement from achieving greater accuracy—the elimination of the gravitational effect of objects other than those being measured and the measurement of a weak force over a period of time. In order to eliminate the gravitational effects of surrounding objects, the University team devised a system in which a turntable's acceleration would be the quantity measured. Two high density tungsten spheres of equal weight are fixed on opposite sides of a turntable. A tiny metal cylinder suspended by a quartz fiber in an airtight, helium-filled chamber is placed in the center of the turntable with the cylinder's axis at an acute angle to the two tungsten spheres. Each side of the cylinder is attracted to the sphere closest to it and it begins to rotate in an attempt to close the angle between it and the sphere. The turntable, however, prevents the cylinder from catching up to the sphere. An optional tracking device attached to the turntable activates a motor which causes the table to rotate as the cylinder begins to move, keeping the angle between the cylinder

and the sphere constant. As the cylinder keeps trying to catch up to the sphere, the table, which floats on a thin layer of air, accelerates and within two hours is making five revolutions per minute.

Dr. Ralph A. Lowry, chairman and professor of aerospace engineering and one of the University researchers, indicated that the problem now is to measure long angular displacements over long periods of time, both of which can be done with a high degree of accuracy. The data on rotation speed are fed into a computer which performs the calculations required to convert the speed into the units by which gravitation is measured. Since so many variables can affect the measurements, precision instruments in a controlled setting must be used. The temperature of the cubicle in the School of Engineering and Applied Science building where the device is located never varies beyond 0.1 of one degree. White gloves are donned in handling the tungsten spheres to prevent soiling them.

Improvements on the device are being made constantly in order to increase its accuracy. For instance, the quartz fiber suspension will be replaced by magnetic suspension to allow the cylinder to "float" unhampered by friction and the slight restoring torque of the quartz fiber.

Other members of the research group which designed and developed the device under a grant from the National Aeronautics and Space Administration are Dr. Hermon M. Parker, professor of aerospace engineering; Dr. A. R. Kuhlthau, associate provost for research and professor of aerospace engineering; Maj. R. D. Rose, assistant professor of physics at the Air Force Academy who received his doctorate from the University of Virginia in August, 1969, and W. D. Fowler, head of the instrumentation group of the University's Research Laboratories for the Engineering Sciences.

ASTROMETRIC TELESCOPE

The University of Virginia's new 40-inch astrometric telescope is scheduled for operation by the fall of 1970.

The new research instrument, which will be located at the University's Fan Mountain Observatory station 17 miles south of Charlottesville, will accurately record stellar positions and observe extremely faint objects in space. The computer-controlled telescope will make rapid and accurate observations and implement a variety of new developments in telescope technology.

The new telescope, which will be situated near a 32-inch reflector telescope and a 10-inch astrograph—a device which classifies stars by temperature, eventually will replace the University's 26-inch refractor telescope installed on the University Grounds in the 1880's.

Participants at the recent ground-breaking for the 36-foot, 10-sided turret building that will house the telescope included Robert McCormick Ayer of Beverly Farms, Mass. He represented the estate of the late Leander McCormick who provided funds for the University's 26-inch telescope in 1882.

The McCormick estate and grants from the National Science Foundation and the National Aeronautics and Space Administration are supporting the new project.

Total cost of the telescope is expected to be just under one-half million dollars.

STARSHINE

Photographic plates of stars taken more than 50 years ago are being pulled from files at the University of Virginia's Leander McCormick Observatory for use in a new project. As part of research aimed at identifying intermediate-age stars, new photographs will be taken of the same regions of the sky and then compared with old plates to observe the movement of the stars over the past half-century.

The two-year study, funded by a \$115,000 grant from the National Science Foundation, will be carried out by Dr. Charles Tolbert, assistant professor of astronomy, and Philip Ianna, research associate, in collaboration with Dr. Adriaan Blaauw, director of the European Southern Observatory in Hamburg, Germany, and former member of the University's Center for Advanced Studies.

The University of Virginia is said to be one of the few places in the world that can do a study like this at this time. Not only does it have files of photographs taken over a 50- to 60-year span, but the same telescope, built in 1881, is still in use. That telescope, a 26-inch refractor-type, was the largest in the world when first installed at the University. It is essential that the same telescope be used for the new photographs so that any difference in a star's position will be due to actual motion and not to variations in equipment. The star's motion will be one of the factors in determining whether the star is old, intermediate-age or young.

In the beginning, our galaxy was a sphere of rotating gas, probably pure hydrogen. As stars began to form, the rotating sphere began to flatten into an ellipsoid. It continued to flatten, still rotating, into a disc shape with a bulge in the middle. Intermediate-age stars would be expected to have

some sort of ellipsoidal distribution, but no evidence yet proves it.

The composition of stars will also be analyzed in an effort to determine their age. The oldest stars are made out of pure hydrogen. Intermediate-age stars have a small amount of heavier elements such as helium, carbon and nitrogen, and the youngest stars are rich in heavier elements. A star's elements can be measured through photoelectric techniques. In the next two years Dr. Tolbert will go to Kitt Peak Observatory in Tucson, Ariz., and Cerro Tololo Interamerican Observatory in La Serena, Chile, to make photoelectric observations of 750 regions of the sky.

It is hoped that a clearer understanding of how our galaxy evolved may be obtained by gathering definite evidence on intermediate-age stars.

AQUARIUS, AGE OF

The 1970 Virginia General Assembly is now history. It was notable for many accomplishments but may well be best remembered not so much for the \$3.8 billion budget or for not increasing taxes on tobacco, as for demonstrating its scientific awareness by creating the Science Museum of Virginia. Attempts to create a state-wide museum system in the past encountered every possible handicap that such endeavors often do, including indifference by Virginia scientists. In the current—and at long last successful attempt to create the museum—it was primarily the scientists of Virginia acting in concert through the Virginia Academy of Science that spearheaded the victory. Indeed the success of this venture portends well for the future of the VAS, because it shows what a group of unreconstructed scientists can do when acting together in a good cause. Careful planning by experts in the Museum field under the direction of a nine man Board of Trustees to be appointed by the Governor, and the staff of the Museum, constitute the next order of business. The Board will need your continuing interest and assistance to bring to fruition a Museum of highest quality as envisioned by the Study Commission. Such a Museum should have a key role in the future of this increasingly polluted world!

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3. Riley, G. A., and Haynes, R. C., Jr., *J. biol. Chem.*, **238**, 1563 (1963).

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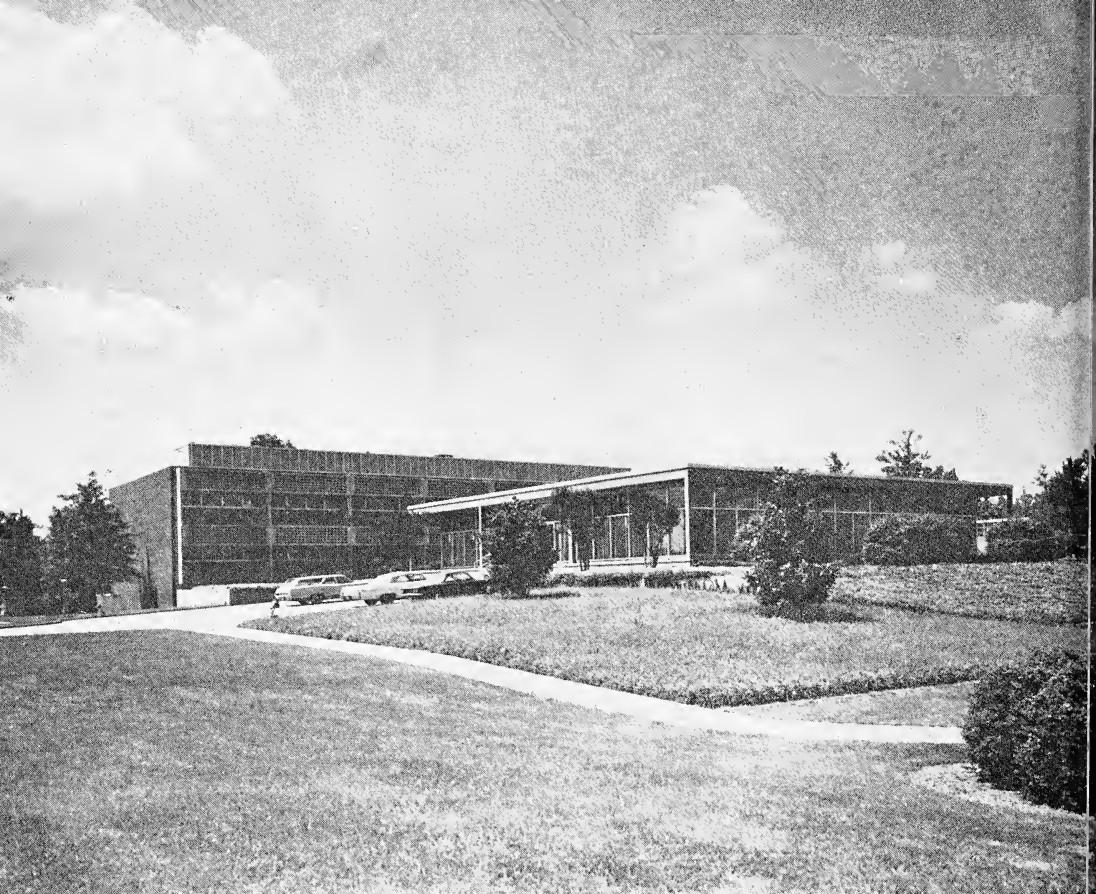
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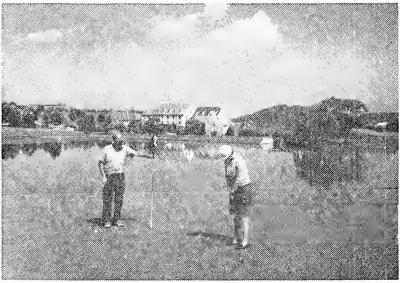
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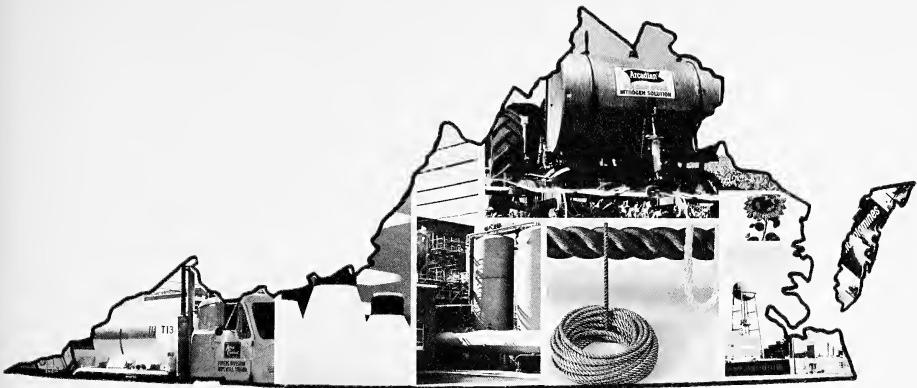
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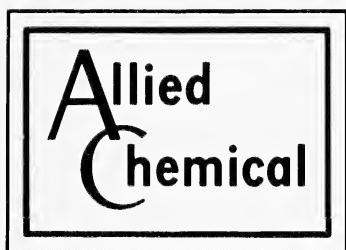
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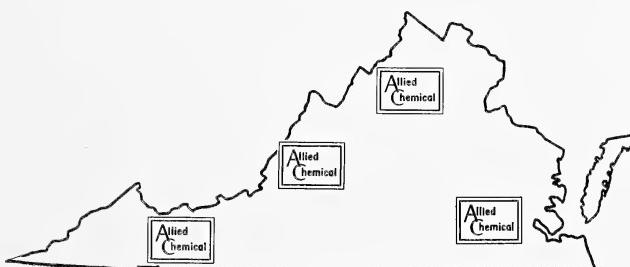


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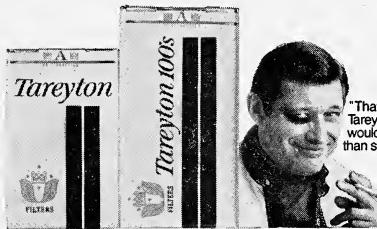
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Soils of the Dismal Swamp of Virginia*

The soils of the Virginia section of the Dismal Swamp were mapped in detail by the writer and Hobart C. Porter in 1952 as a project of the Virginia Agricultural Experiment Station. Soil borings and exploratory pits were made at regular intervals along all of the major roads, trails, railroad beds, even deer paths and large ditches. In addition all of the principal waterways were traveled to gain access to sections of the Swamp otherwise inaccessible. These included the Dismal Swamp Canal Feeder Ditch into Lake Drummond (Fig. 1) and the Portsmouth, Jericho, and Washington ditches.

Soil characteristics such as color, soil particle size, particle arrangement and consistency were carefully studied and documented. On the basis of their characteristics the soils were classified and mapped into 7 categories and the location of each was plotted

on an aerial photograph which served as a base map. The seven soils shown on the soils map (Fig. 2) have pedological classification names, all of which have been selected, documented and correlated by the U. S. Department of Agriculture in its official soil classification system. This survey formed the basis of the findings and conclusions made in this report.

The soil recognized as Mucky Peat (7)¹ which occupies about three fourths of the total area of the Swamp is described in detail in the text. Detailed descriptions of the other six can be found in the Appendix.

The soils potential of the Dismal Swamp has attracted and challenged many prominent Virginians from colonial times to the present. William Byrd, a colonial Virginia planter, surveyed the line separating Virginia and North Carolina. He recorded the results of his exploits in his classical "History of the Dividing Line". This includes fascinating accounts of his trials in establishing this line through parts of the Dismal Swamp.

Both George Washington and Patrick Henry purchased sections of this swamp because they were convinced that the rich-looking black soil could be drained and become prime agricultural land. In fact, George Washington began a survey of the swamp lands and engineered a large drainage ditch extending from the western portion of the swamp all the way to Lake Drummond. This ditch can still be used to float small boats or canoes (Fig. 3).

The outer boundaries of the Dismal Swamp are indistinct and irregular except for the western edge which constitutes a geological ridge called the escarpment. The "Wicomico terrace" extending westward from this escarpment rises about 50 feet above the "Dismal Swamp terrace" level, eastward of this ridge.

Marginal marshy swamp lands extend groping fingers into better drained inorganic soils surrounding the swamp. These extensions have typical soil characteristics of true swamp peats, such as the dark brown or black organic surface soil layers. They also support the dense cane and shrub growth



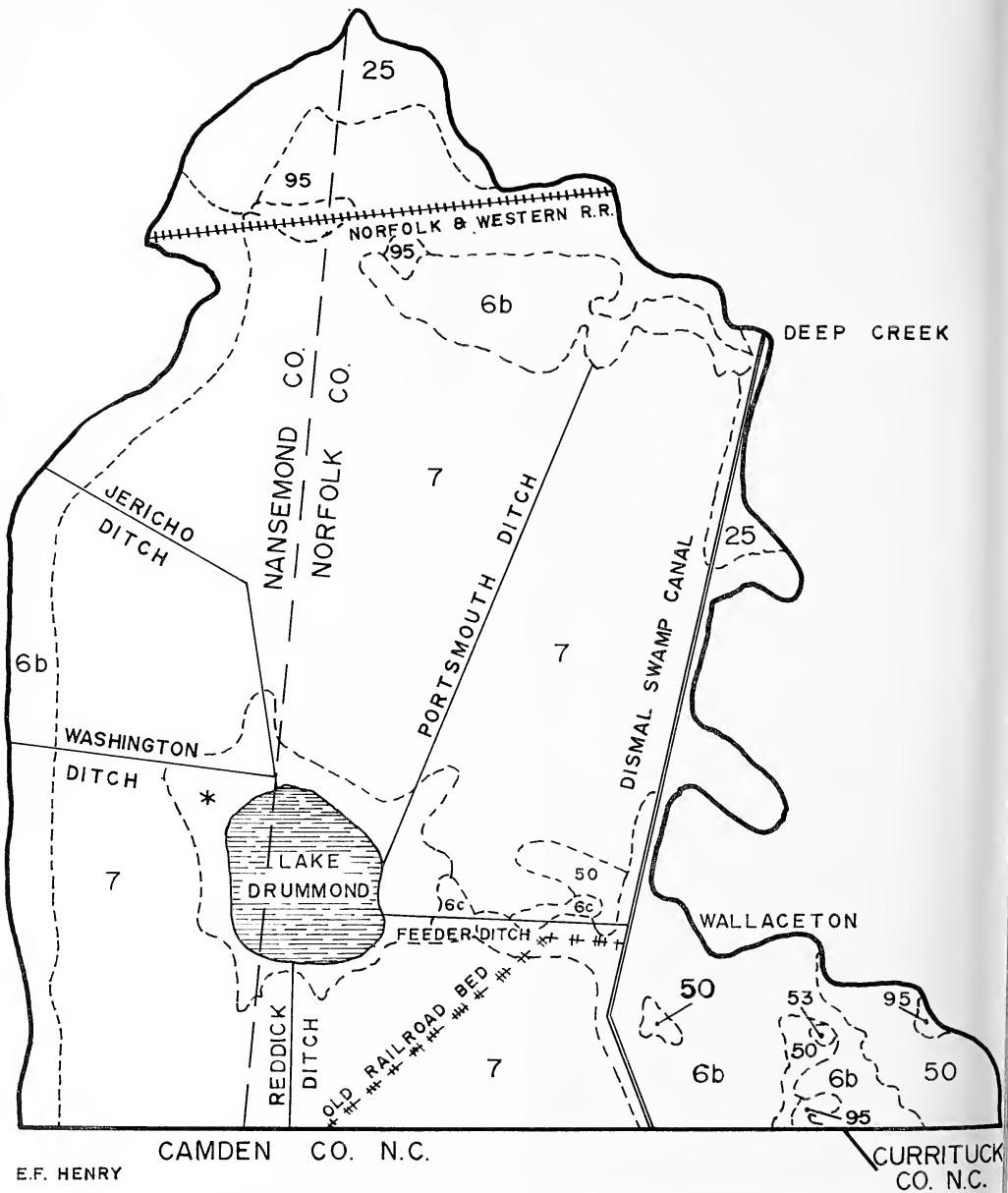
FIG. 1—Feeder ditch into Lake Drummond, Dismal Swamp of Virginia.

* Editor's note: This is the third of a series of articles on the Dismal Swamp appearing in The Virginia Journal of Science. Previous articles appeared in the Fall 1969 numbers *The Birds of the Dismal Swamp*, Va. J. Sci., 20, 158 (1969), and *Forests and Forestry in the Dismal Swamp*, Va. J. Sci., 20, 166 (1969).

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¹ Numbers in parentheses refer to numbers in the map legend (Fig. 2) and in the Appendix.



E.F. HENRY

FIG. 2—Soil map of Dismal Swamp of Virginia, scale approx. $\frac{1}{2}$ inch = 1 mile. Key: 7—Mucky peat; 6b—Mucky peat, shallow over loams; 6c—Mucky peat, shallow over sands; 25—Portsmouth loam; 50—Portsmouth mucky loam; 53—Woodstown fine sandy loam; 95—Othello loam, dark surface phase.

* Dashed line around Lake Drummond is area of Deep Mucky Peat.



FIG. 3—Washington Ditch, Dismal Swamp of Virginia.

found in the swamp proper. An outstanding example of this is the "Green Sea" in Norfolk County, Virginia (Fig. 4). This area is so called because its level topped growth of green canes and dense undergrowth sway with the wind to give one the illusion of sea waves.

Normal drainage around the outer fringe of the Swamp is greatly restricted by railways, roadbeds, and ditches which have been constructed across natural water outlets. In many places these obstructions have caused excessive ponding.



FIG. 4—Tall cane growth in Green Sea area of Dismal Swamp, Norfolk County, Virginia.

The Swamp climate is temperate, characterized by long humid summer seasons and mild winters. The average rainfall at Wallacetown at the eastern edge of the Swamp is about 51 inches annually.

Estimates of the overall size of the Dismal Swamp vary considerably because of continuous urbanization encroachment and land reclamation of its outer fringes. In addition, opinions differ greatly as to what constitutes poorly drained soils and true Swamp land. In 1900 the total Swamp area in North Carolina and Virginia was estimated at about 768,000 acres. A current conservative estimate of the total area is about 256,000 acres. Kearney's² figures are higher. He wrote in 1901 "The total area of the Dismal Swamp is estimated at about 3,900 square kilometers (1500 square miles) which comprises all extensive bodies of hydrophilic forest lying between the Elizabeth River and the mouth of the James on the north, and Albemarle Sound on the south. More than one half of this area lies in North Carolina—an additional 1,800 square kilometers (700 square miles) is computed to have been reclaimed from the original area of the great Swamp". Regardless of the original area it is well known that the overall size is steadily decreasing as it gives way to modern drainage and reclamation methods.

The underlying or inorganic soil materials of the Dismal Swamp consist principally of marine sediments of sand, silt and clay. These terms, practically defined, indicate the size of the individual soil particles from the largest sands through the intermediate silts to the smallest clays. They were deposited as low terraces in earlier geological periods. The mineral soil material adjacent to the Suffolk escarpment consists mainly of silts and clays indicating river rather than oceanic origin and deposition. There is no specific evidence that the original soil material upon which the dark colored organic soils have developed are any different from similar soil materials surrounding the Swamp. During the severe drought of 1952 in which a large portion of Lake Drummond dried up, soil borings were taken in the lake bottom (Fig. 5). These borings revealed that pure white



FIG. 5—Lake Drummond—showing effects of extreme drought in 1952; ----- lines indicate normal water line.

² Kearny, T. H., *Report on a Botanical Survey of the Dismal Swamp Region*, U. S. Dept. Agric. Div. of Botany, 5, 321 (1901).

sand underlaid a mat of decayed vegetation and Mucky Peat adjacent to the lake shore. This mat apparently becomes thinner towards the center of the lake, which supports a theory that the lake was created by crater depression following an intense fire and burning of the peat deposits.

The thickness of the black organic soil layers varies. This is due partly to sporadic uneven burning of the upper soil layers. The depth, fertility and acidity of the surface soil layers govern the type of vegetation which it supports.

About three-fourths of the total swamp area in Virginia has been classified as Mucky Peat (7) which, as the name indicates, is an intergrade between *true peat* in which materials of vegetable origin are readily recognized, and "muck" which has decomposed to an extent that plant remains are indistinct. This material varies in thickness, color, ash content, stage of decomposition and in original organic matter source. It ranges in thickness from three to fifteen feet over a mineral sand and clay substratum. An area approximately one half mile wide of deep phase of this Mucky Peat completely surrounds Lake Drummond. Small isolated areas of this deep peat occur in other parts of the swamp. In places the mineral soil substratum is white and chalky with marl deposits and marine fossil shells. Those deposits can be seen in the steep banks of the Feeder Ditch in the vicinity of Lake Drummond. The surface layer of this organic material consists of loose leafy plant litter mainly from maple, gum, cane, white cedar, and pine. This overlies the *first* peat layer, a shallow layer of reddish-brown granular semi-decomposed organic material, containing fragments of wood and forest litter in various stages of decomposition. Under this organic mat living roots and stems exist in a soil climate favoring both vegetative growth and the existence of microorganisms. This overlies coarser water-soaked and well preserved logs, stumps, and roots including cypress.

The *second* peat layer is chocolate brown, sticky and plastic containing fragments of cypress knees, gum roots, cone scales, and coniferous pollen. It merges at depths of about 30 inches into grayish brown clayey soil containing sedge, achenes, cane rhizomes and small quantities of gritty sand that were probably transported during periods of flooding and erosion.

The *third* peat layer consists principally of decomposed fern and aquatic plants, fallen tree branches, interwoven with roots and mucky residue.

The *fourth* layer, from about five to seven feet from the surface, is a grayish brown sedimentary fibrous peat derived from wet-marsh vegetation containing stems of cones and sedges. The lower part of this layer is soft and fine textured. The presence of woody fragments is evidence that islands of trees and shrubs existed in drier sections of the marsh. Beneath all this is sedimentary coarse peat. At depths of about nine feet this merges into a basal layer of brown chaffy peat of wood origin with tree stumps still intact. The thickness of the peaty layers varies greatly from place to place.

The large areas of Mucky Peat soils which lie

adjacent to Camden County, North Carolina, are the most desolate and isolated. These areas are usually inundated throughout the year and harbor little animal life of any kind. This is perhaps the section of the Dismal Swamp that prompted its first surveyor, William Byrd, of Virginia, to select the name "Dismal".

Mucky Peat soils are not (now) considered suitable for agricultural use. Few attempts have been made to drain or reclaim them. Many of the areas are little more than shallow marshes, virtually inaccessible, and remote.

The second most extensive soil in the Dismal Swamp has been classified as Mucky Peat, shallow over loams (6b). It is similar to the Mucky Peat heretofore described in most respects. It differs in having a shallower layer of organic soil which is underlain by mixed and interstratified layers of fine textured clayey and silty soils.

This shallow phase of Mucky Peat occurs mainly on the western rim of the Swamp in Nansemond County and near Wallacetown in Norfolk County. It occupies level to nearly level relief. Smoldering peat fires in past years have created shallow water filled craters which characterize this soil. It is presumed that it is actually a burned phase of the deeper Mucky Peat, since it occurs on the Swamp periphery where the water table has been lowered by drainage operations. As the water table is lowered the soil dries out and burns or decomposes readily. For example, in the fall of 1934 serious peat fires occurred in the northern section of the Swamp, particularly along the Norfolk and Western Railroad in the vicinity of Magnolia. The surveying party encountered large areas of dark colored ashy residues in this vicinity. This undrained highly acid soil has little or no present value as agricultural land.

Another phase of the Mucky Peat soil has been classified as Mucky Peat, shallow over sands (6c): This soil is not extensive occurring mainly in the vicinity of the Feeder Ditch. As the name implies it is similar to the other Mucky Peat soils except for being underlain at shallow depths with sands.

There is no clear line of demarcation between the true mucky peat soils comprising the core of the Dismal Swamp and its outer fringe area. The organic soils merge imperceptibly into transitional poorly drained inorganic soils surrounding it. These transitional soils have been classified and mapped in accordance with the natural scientific soil classification system. The individual units in this classification system are usually named after localities in which they were first encountered. For example, agricultural scientists first identified the soil series known as "Portsmouth" near Portsmouth, Virginia, in 1902. The predominant Portsmouth soil (25) occurs in many Atlantic Seaboard states extending from New Jersey to Florida. It is naturally very poorly drained and unproductive; however, when artificially drained it becomes useful for many agricultural purposes. It is especially well suited for growing ornamental shrubs and plants. One of the largest plant nurseries in the world is located in this soil near Norfolk, Virginia.

Small areas of the phase of the Portsmouth loam, called Portsmouth Mucky loam (50), have been mapped. This phase is not extensive. It differs only in having a higher organic matter content in its surface layer.

Another swamp transitional soil has been classified as Othello loam, dark surface phase (95). This soil like the Portsmouth loam, occurs in small scattered areas in the extreme northern and southeastern sections of the Virginia portion of the Dismal Swamp. It is not a true swamp soil, but does have a dark colored surface layer.

Other swamp transitional soils include members of the thick clayey Bayboro and the shallow sandy Pocomoke series.

One of the most unusual and interesting soil areas found in the entire Dismal Swamp area is known as "Smith Ridge." This area is completely incompatible with its surrounding environment. It consists of an elevated, oval shaped soil island classified as Woods-town fine sandy loam (53) completely encircled and virtually isolated by low-lying very poorly drained swampy lands. It is apparently a remnant of an older higher geological soil area. Here the soil is moderately well drained, sandy textured and has no organic deposits or layers which can be closely related to its surrounding environment. This high better drained spot was once used as camping grounds for Indian tribes of eastern Virginia. Arrow heads, tomahawks, and grinding stones and other artifacts have been found at this site.

The relentless pressures for residential building sites and commercial expansion will inevitably overcome the physical and economic barriers which have heretofore effectively restricted development of the "Swamp lands" such as those of the "Great Dismal." Their proximity to large growing cities constituting the metropolitan fringes of Norfolk, Portsmouth, Chesapeake, and Suffolk virtually assures this transition.

Those of us soil scientists who have explored the pedological secrets, traversed the narrow bear and deer trails and experienced the quiet solitude of Lake Drummond, encircled by its deep and fragile Peaty Glades, can only hope that at least this part of Virginia's Great Dismal can be left undisturbed in its natural beauty and legendary history.

APPENDIX

Mucky peat, shallow over loams (6b)

A representative profile description follows:

0-6 inches, reddish-black to black, partly decomposed organic matter mixed with small roots and dark-colored, fine-textured, ashy soil material. 6 to 15 inches, reddish-black, finely divided mucky peat containing some roots and decomposed woody fragments. 15 to 25 inches, reddish-black, fibrous mucky peat containing some partly decomposed sedge peat. 25 to 40 inches, light-gray to gray silty clay loam or loam; slightly plastic and sticky. 40 to 50 inches, mottled gray and light-gray fine sandy clay loam.

Mucky peat, shallow over sands (6c)

A representative profile description follows:

0 to 6 inches, black, partly decomposed organic matter and small roots mixed with mucky peat. 6 to 20 inches, reddish-black, finely divided mucky peat containing some small roots and fragments of wood. 20 to 30 inches, gray, nearly loose fine sandy loam to loamy fine sand.

Portsmouth loam (25)

A representative profile description follows:

Surface soil—

0 to 12 inches, black, very friable loam. 12 to 15 inches, grayish-brown, light fine sandy clay loam with a few, coarse, distinct yellowish-brown mottles.

Subsoil—

15 to 23 inches, light olive-gray, slightly plastic and sticky, heavy fine sandy clay loam with a few, fine distinct mottles of yellowish brown and strong brown.

23 to 27 inches, light brownish-gray, slightly sticky fine sandy loam with a few, coarse, prominent mottles of yellowish brown.

Substratum—

27 to 45 inches, light-gray, loose fine sand.

Portsmouth mucky loam (50)

A representative profile description follows:

Surface soil—

0 to 8 inches, very dark brown, very friable mucky loam. 8 to 13 inches, dark grayish-brown mucky loam.

Subsoil—

13 to 22 inches, grayish-brown to gray, plastic, heavy fine sandy clay loam.

22 to 30 inches, light brownish-gray, plastic, heavy fine sandy clay loam with a few, medium, distinct mottles of light brown.

Substratum—

30 to 40 inches, light-gray loose sand.

Othello loam, dark surface phase (95)

A representative profile description follows:

Surface soil—

0 to 6 inches, very dark brown, friable loam.

Subsoil—

6 to 10 inches, light brownish-gray, firm, light fine sandy clay loam; a few, fine, faint mottles of light olive brown.

10 to 30 inches, gray, very plastic and very sticky, heavy fine sandy clay loam with strata and pockets of silty clay loam; common, coarse, distinct mottles of strong brown.

30 to 35 inches, gray, slightly sticky, heavy fine sandy loam with pockets of firm fine sandy clay loam; common, medium, distinct strong-brown mottles.

Substratum—

35 to 45 inches, light-gray, loose loamy fine sand; a few, medium, faint mottles of light olive brown.

Woodstown fine sandy loam (53)

A representative profile description follows:

Surface soil—

0 to 6 inches, very dark brown, very friable fine sandy loam.

6 to 11 inches, yellowish-brown, friable fine sandy loam faintly streaked with dark brown.

11 to 14 inches, yellow to brownish-yellow fine sandy loam; slightly sticky when wet.

Subsoil—

14 to 22 inches, yellow, light sandy clay loam with many, medium, distinct yellowish-brown mottles.

22 to 36 inches, yellow, slightly plastic and slightly sticky fine sandy clay loam with many, coarse, prominent mottles of strong brown and light yellowish brown.

Substratum—

36 to 60 inches, yellowish-brown loose sand with common, coarse, distinct mottles of light gray.

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An Ultrastructural Study of the Prevention of the Acute Ethanol Induced Fatty Liver by Chlorcyclizine

Abstract—Alterations in the ultrastructure of hepatic tissue as a result of acute and chronic exposure to ethanol have been reported. The specific cause and the resulting morphological effects of these alterations is still unclear, and the precise mechanism by which ethanol produces a fatty liver has not been elucidated.

We have previously reported that chlorcyclizine [1-(*p*-chloro- α -phenylbenzyl)-4-methylpiperazine] may maintain hepatic fatty acid oxidation at a normal rate in ethanol-treated rats. The following groups of animals were studied at 4, 8 and 16 hours after intubation with either ethanol or glucose solution: intraperitoneal saline and oral glucose (control group); intraperitoneal saline and oral ethanol; intraperitoneal chlorcyclizine and oral ethanol.

Biochemically the peak of the fatty liver occurred 8 hours after intubation. The major ultrastructural changes observed in ethanol-treated rats were in the smooth endoplasmic reticulum (SER) and in the mitochondria. Pretreatment with chlorcyclizine completely prevented the mitochondrial ultrastructural changes and also the increase observed in liver triglyceride after ethanol intubation. Chlorcyclizine did not appear to reverse the ethanol induced cytological changes in the SER. Since fatty acid oxidation occurs primarily in the mitochondrion and since the drug maintains the structural integrity of this organelle in ethanol-treated rats, the present data suggest the intracellular site of the protective action of chlorcyclizine is on the mitochondria.

Introduction

Not all investigators are agreed on the ultrastructural changes produced in hepatic parenchymal cells by acute ethanol intoxication. Ashworth *et al.*, (1, 2) could find no electron microscopic evidence of changes in the endoplasmic reticulum up to 7 hours after the administration of ethanol in an amount sufficient to produce a fatty liver in rats. Similarly, Stein and Stein (3) could find no change in the endoplasmic reticulum nor in mitochondria up to 16 hours after the administration of a large amount of ethanol. On the other hand Hartroft and Porta (4) reported that as early as 4 hours after ethanol administration to rats there was a marked increase in the size of mitochondria and numerous bizarre shapes were observed. Porta and Hartroft (5) later demonstrated that the enlargement and distortion

of mitochondria produced by ethanol was apparently due to a coalescence of mitochondria and a fusion of limiting membranes. They also showed that 4 hours after ethanol there was an increase and a dilatation of the smooth endoplasmic reticulum whereas at 16 hours the smooth endoplasmic reticulum was markedly diminished.

The precise mechanism by which acute ethanol intoxication produces a fatty liver has not been completely elucidated. Many authors (6-9) feel that a major factor in the etiology of the fatty liver is an ethanol-induced decrease in the hepatic oxidation of fatty acid. We have recently reported that the depression of hepatic fatty acid oxidation produced by ethanol was prevented by pretreatment with chlorcyclizine, [1-(*p*-chloro- α -phenylbenzyl)-4-methylpiperazine], a piperazine antihistamine and a stimulant of hepatic microsomal enzyme activity (10, 11). Although there is little agreement concerning the ultrastructural changes in hepatic parenchymal cells produced by ethanol intoxication we felt that the protective effect of chlorcyclizine must be exerted on the mitochondrion since it is well established that hepatic fatty acid oxidation is a function of this cellular organelle. Therefore, the purpose of the present investigation was 1) to evaluate the ultrastructural changes in liver cells throughout the development of the acute ethanol-induced fatty liver; 2) to provide ultrastructural evidence concerning the site and for the possible mechanism of action of chlorcyclizine.

Materials and Methods

Female albino rats (Holtzman Co., Madison, Wisconsin) weighing approximately 160-180 grams were used throughout. All rats were fasted for 8 hours prior to intubation with ethanol in the amount 3 g/kg body weight and were allowed tap water *ad libitum*. Chlorcyclizine was administered intraperitoneally in the amount of 25 mg/kg daily for 3 days. Control rats were injected with saline and intubated with isocaloric glucose. The animals were

killed at 4, 8, and 16 hours after intubation and liver samples were taken for electron microscopy and for triglyceride analysis. There were 6 rats in each group at each time period.

For electron microscopic studies tissues were taken immediately upon sacrificing the animals, cut into approximately 1 mm³ blocks, fixed for 2 hours in 2% glutaraldehyde, made isotonic with cacodylate buffer (12) and post-fixed for 1 hour in 1% osmium tetroxide in phosphate buffer at pH 7.2 (13). Following fixation the tissues were dehydrated in a graded series of alcohol, embedded in DER-332 and cut on the Porter-Blum MT-2 ultramicrotome. Sections were stained with lead citrate (14) and uranyl acetate and examined with the RCA EMU-3E or 3G electron microscope.

The biochemical techniques employed have been described previously (10).

Results

The peak of the ethanol induced fatty liver was observed 8 hours after intubation (Fig. 1) and was manifested by a 300% increase in the concentration of liver triglyceride. The fatty liver was still present at 16 hours and although it was reduced 32% from the peak levels observed at 8 hours, liver triglyceride levels were still elevated 100% above control levels. In marked contrast, no change in the concentration of liver triglyceride was observed in animals pretreated with chlorcyclizine and intubated with the same dose of ethanol. These data provide biochemical evidence that chlorcyclizine pretreatment completely prevented the development of the ethanol-induced fatty liver.

The glucose-intubated animals served as the control group. Although liver sections of this group were studied at all time periods after intubation,

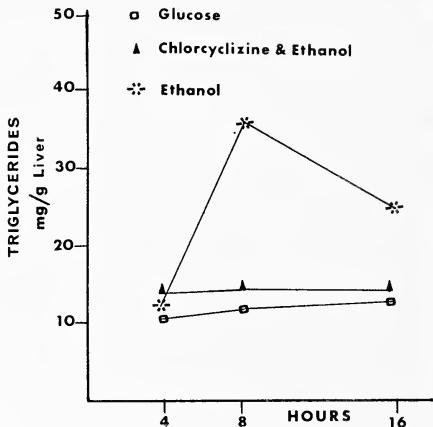


FIG. 1—Complete prevention of the acute ethanol-induced fatty liver by chlorcyclizine. Each point represents the mean value of six rats.

no cytoarchitectural differences were observed in any of the control sections and for that reason a representative section will be described. Nuclear chromatin was finely dispersed and appeared as fine filaments or granules. The nucleoli consisted of fine fibrils or dense granules. The nuclear membrane presented as a typical unit membrane. The rough endoplasmic reticulum (RER) often exhibited a parallel arrangement and occasional groups of free ribosomal granules were encountered (Fig. 2). The smooth endoplasmic reticulum (SER) was randomly dispersed throughout the cytoplasm, and consisted of a typical canalicular system. The mitochondrial structure appeared in no way atypical although an occasional enlarged mitochondrion was observed. The Golgi apparatus consisted of several flattened cisternae or saccules in close parallel arrangement. An occasional lipid droplet was observed within the cytoplasm of the normal cell.

For descriptive purposes only the ultrastructural changes found in hepatic parenchymal cells will be described under the heading of the various cellular organelles.

Rough Endoplasmic Reticulum (RER). Ethanol administration did not produce any alteration in the RER at any time period studied (Fig. 3 and 4). Similarly, pretreatment with chlorcyclizine did not alter the appearance of the rough endoplasmic re-

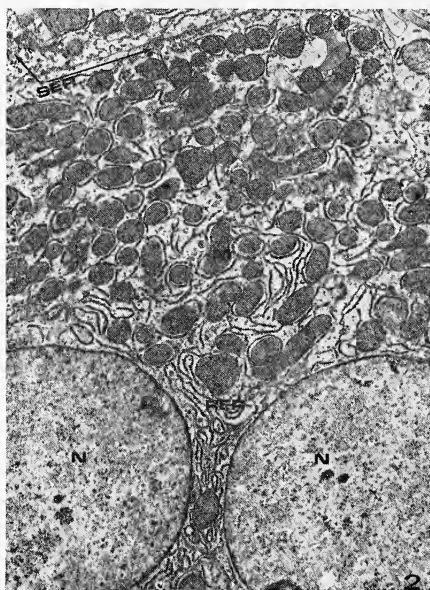


FIG. 2—Control (saline and glucose—8 hours) hepatic parenchymal cells of rat showing arrangement of mitochondria (M), smooth and rough endoplasmic reticulum (SER and RER) and nuclei (N). $\times 15,500$.

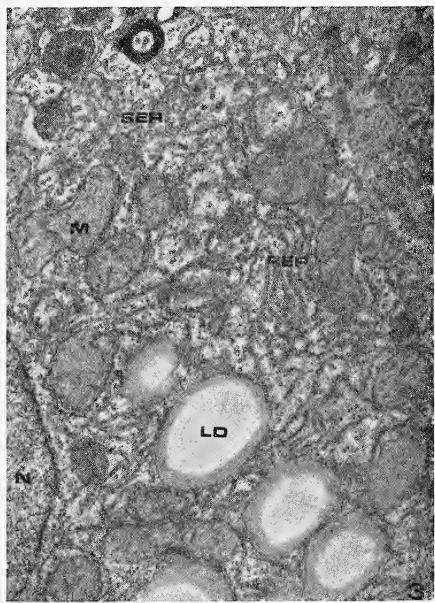


FIG. 3—Eight hour saline and ethanol-treated rat exhibiting lipid droplets (LD), enlarged and bizarre shaped mitochondria (M), dilatation and vesiculation of smooth endoplasmic reticulum (SER), rough endoplasmic reticulum (RER) and portions of nucleus (N). $\times 22,000$.

ticulum in ethanol-treated animals (Fig. 5). This observation would support the findings of Ashworth *et al.*, (1, 2) who demonstrated that the ultrastructure and the protein enzymatic functions of the rough endoplasmic reticulum were not altered by acute ethanol intoxication.

Smooth Endoplasmic Reticulum (SER). The SER of ethanol-treated animals was increased, dilated and vesicular at 8 and 16 hours after ethanol intubation (Fig. 3 and 4). The degree of alteration was comparable at both time periods. In ethanol-intubated animals pretreated with chlorcyclizine (Fig. 5) the degree of vesiculation, dilatation and expansiveness of the smooth endoplasmic reticulum was comparable to that observed in the ethanol-treated group.

Mitochondria. The mitochondria exhibited marked swelling at 8 (Fig. 3) and 16 hours (Fig. 4) after ethanol administration. Many enlarged mitochondria of bizarre shape were observed and these may have been formed by the coalescence of mitochondria and an accompanying dissolution of their limiting membranes. The most marked alterations in mitochondrial appearance occurred 8 hours after intubation and this was the peak of fatty liver development (Fig. 3). Pretreatment of ethanol-treated rats with chlorcyclizine prevented the ethanol-in-

duced alterations in mitochondrial architecture (Fig. 5). Very infrequently an occasional enlarged bizarre shaped mitochondrion was observed in the drug pretreated group.

Lipid. A marked increase in the number of lipid droplets were observed in the cytoplasm of the ethanol treated animals at 8 and 16 hours after intubation (Fig. 3 and 4). Lipid droplets were more numerous at 8 hours (Fig. 3), the peak of the fatty liver development. These droplets measured 0.5 to 4.0 microns in size and frequently indented the nuclear membranes (Fig. 3). The margins of the larger droplets were frequently observed to be irregular, indented and scalloped. Fusion of lipid droplets was quite common. In chlorcyclizine protected animals very little lipid material was observed 8 and 16 hours after intubation (Fig. 5). Only an occasional lipid droplet comparable to that observed in the isocaloric control group was observed.

The Golgi apparatus, lysosomes, autophagic vesicles and other cytoplasmic components were not altered by ethanol intoxication nor by pretreatment with chlorcyclizine.

Discussion

The present data demonstrated that one of the major ultrastructural changes in hepatic parenchy-

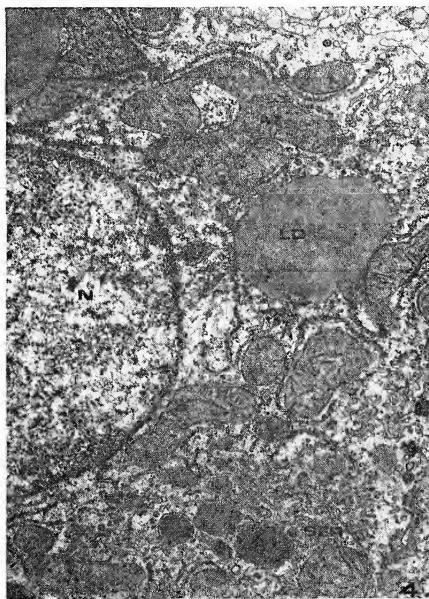


FIG. 4—Sixteen hour saline and ethanol treated rat. Enlarged, bizarre shaped mitochondria (M), lipid droplets (LD), portions of a nucleus (N), and an increase in the smooth endoplasmic reticulum (SER), are exhibited. $\times 25,000$.

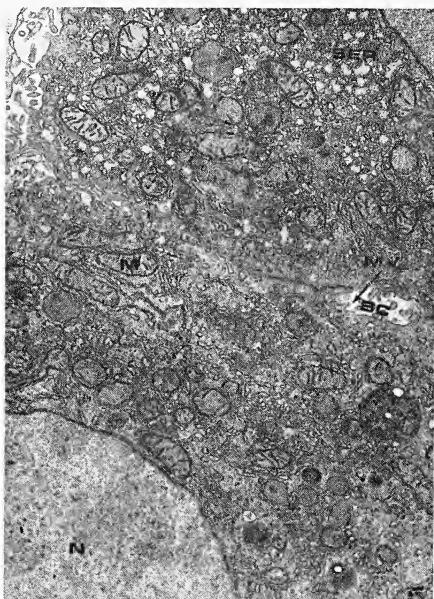


FIG. 5—Eight hour chlorcyclizine and ethanol treated rat illustrating the vesication and dilatation of the smooth endoplasmic reticulum (SER) and normal appearing mitochondria (M). A cross section of bile canalculus (BC), demonstrating microvilli (MV), and portions of nuclei (N) are present. $\times 20,000$.

mal cells produced by acute ethanol intoxication was in the mitochondria. These organelles were markedly increased in size and because of apparent coalescence of numerous mitochondria they had become distorted and numerous bizarre shapes and sizes were observed. The cristae were disoriented rather than in the typical parallel arrangement. The rough endoplasmic reticulum was not altered at any time period after ethanol administration. However, the smooth endoplasmic reticulum in ethanol-treated rats appeared increased in quantity and was markedly dilated and vesicular (Fig. 3 and 4). These findings are in agreement with the findings of Hartroft and Porta (4) and Porta and Hartroft (5) who reported similar alterations in these cellular organelles in rats exposed to acute ethanol intoxication. It is interesting in that we were able to show similar changes in ultrastructure of the same organelles by using a dose of ethanol half that used by Porta and Hartroft (5).

It would seem likely that alterations in the size and shape of mitochondria may be indicative of changes in the activity of the mitochondrial enzymes. Since mitochondria are the intracellular site of hepatic fatty acid oxidation, the depression of fatty acid oxidation reported by many authors (6-9,

11) must have been due to a loss of some essential mitochondrial enzyme activity. The fact that chlorcyclizine pretreatment has previously been shown to maintain hepatic fatty acid oxidation at a normal rate in ethanol-intoxicated rats (9, 11), and in the present study to maintain the structural integrity of mitochondria, suggests that the site of action of chlorcyclizine is at the mitochondria. The present data however, do not suggest any possible mechanism by which the drug exerts a protective effect. Although alterations in the endoplasmic reticulum are known to be associated with the development of the fatty liver produced by chronic ethanol administration (15) it may be that changes in this organelle are not directly involved in the development of the acute ethanol-induced fatty liver. The ultrastructural changes in the smooth endoplasmic reticulum observed in our ethanol-treated rats were neither prevented nor ameliorated by pretreatment with chlorcyclizine even though the drug produced complete prevention of the fatty liver and maintained a normal appearance of the mitochondria.

It has been demonstrated (6, 16, 17) that various antioxidant agents protect against fatty infiltration of the liver produced by acute ethanol intoxication. Others (5) have confirmed these findings and have shown that these antioxidants also prevent ultrastructural changes in the mitochondria and the endoplasmic reticulum. The mechanism by which antioxidants protect against fatty liver development has not been established. Di Luzio and Hartman (6) have presented direct biochemical evidence to show that antioxidants prevent the increase in hepatic lipid peroxidation produced by acute ethanol intoxication. However, others (18) have been unable to confirm these findings.

It has been proposed by Recknagel (19) that antioxidants may protect against various types of hepatotoxicity by acting as scavengers of free radicals. Lipid peroxides may be considered to be free radicals and if the antioxidants can either prevent the development or reduce the toxicity of these radicals they would protect against the hepatic damage thought to result from lipid peroxides. However, because of recent conflicting findings (6, 18) the role of lipid peroxide formation in the etiology of the acute ethanol-induced fatty liver has not been clarified. Since chlorcyclizine possesses the necessary structural configuration to act as a scavenger of free radicals (10, 19) and since it produces similar biochemical and electron microscopic protection against the fatty liver produced by ethanol it is possible that the drug acts in a manner similar to the antioxidants.

On the other hand, others (20) feel that the initial biochemical defect produced by ethanol intoxication which results in the development of a fatty liver is an alteration in the hepatic ratio of $\text{NAD}:\text{NADH}_2$. Lieber (20) feels that all the deranged metabolic sequelae observed after ethanol intoxication result from an initial and selective action of ethanol on the status of this nucleotide. It has been demonstrated (21) that high doses of ethanol transiently lower the hepatic ratio of $\text{NAD}:\text{NADH}_2$. We

have recently reported that the hepatic ratio of NAD:NADH₂ is lowered by acute ethanol intoxication and that this effect may be blocked by pretreatment with chlorcyclizine (11). Therefore, it is possible that the protective effect of the drug may be related to its ability to maintain a normal hepatic ratio of this nucleotide. A more detailed study concerning the sequence of events in hepatic lipid peroxidation and in changes in hepatic NAD:NADH₂ will establish if these events, and the subsequent fatty liver are causally related and which is the major factor involved in fatty liver production. A simultaneous study of the effects of chlorcyclizine will help to establish the mechanism of action of the drug.

Conclusion

The development of the acute fatty liver induced by 3 g/kg of ethanol and the protection afforded by chlorcyclizine were studied by electron microscopy. Biochemically the peak of the fatty liver occurred 8 hours after intubation and was still present at 16 hours although it was reduced 32% from peak levels. No increase in liver triglyceride accumulation above the levels observed in the isocaloric glucose control group was observed in rats pretreated with chlorcyclizine and intubated with the same amount of ethanol. The major ultrastructural changes observed in ethanol-treated rats were in the smooth endoplasmic reticulum (SER) and in the mitochondria. The SER of ethanol-treated rats was increased, dilated and vesicular at all time periods after ethanol intubation. Pretreatment with chlorcyclizine did not prevent these alterations in the SER. Profound ultrastructural changes produced by ethanol-intoxication were also observed in mitochondria. The mitochondria were enlarged and many bizarre shapes were observed; the cristae appeared disoriented. With the exception of an occasional abnormal mitochondrion similar in size and shape to those observed in ethanol-treated rats, pretreatment with chlorcyclizine completely prevented the ultrastructural changes in mitochondria produced by ethanol. Chlorcyclizine pre-treatment is known to prevent the depression of hepatic fatty acid oxidation

produced by acute ethanol intoxication (9). Since fatty acid oxidation occurs primarily in mitochondria and since the drug maintains the structural integrity of mitochondria in ethanol-treated rats, the present data suggest the intracellular site of the protective action of chlorcyclizine is on the mitochondria.

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Aplanospore Formation and Germination in *Spirogyra* sp.*

Abstract—In the spring of 1969 a species of *Spirogyra* was collected in shallow water along the edge of a stream in Tanglewood Park, Forsyth County, North Carolina, showing definite spore formation. The same alga has been collected a number of times during the summer, fall and winter of 1969–70 from the same general location. Observations and study have been made on spore formation and germination of this *Spirogyra* over a period of about twelve months. In spore formation the cells become conspicuously inflated in the central region, the protoplasts round up into dense spherical masses and secrete smooth thick walls. Since no indication of conjugation has been observed in any of this material, the spores are considered to be aplanospores. The spores germinate readily in the laboratory after a short period of dormancy. Germination is enhanced by storing ripe spores at a temperature of 8°C for about three weeks. The *Spirogyra* in question fits the description of *S. mirabilis* (Hass.) Kütz. fairly well with the notable exception of the shape of the spores which are always spherical in our material, while they are described as ovoid or ellipsoid in *S. mirabilis*. Whether the *Spirogyra* with which we are dealing should be considered a new species or a variant of *S. mirabilis* is a question yet unresolved.

Introduction

The formation of nonmotile spores, other than zygospores, is a common phenomenon among the Chlorophyceae. Such spores have been referred to as akinetes, hypnospores, aplanospores, parthenospores, and azygospores. Akinetes are formed by the thickening of the existing cell walls and the protoplasts going into a resting state. These are rare in *Spirogyra*; Randhawa (1) describes them as occurring in *Spirogyra farlowii* Transeau. The term hypnospore seems to be applied to any type of spore which forms an unusually thick wall and goes into a long resting period. The distinction between aplanospores and parthenospores is not always clear. According to Wille (2), ". . . arrested zoospores which have skipped the motile phase are termed aplanospores." Smith (3) agrees with Wille in considering aplanospores as abortive zoospores. It seems logical to consider as parthenospores only those spores formed from gametes which failed to unite during conjugation, and are found in conjugating filaments, interspersed among the zygospores. On this point Smith (3) says:

"Cells of Zygnemataceae may have a rounding up of the protoplast and a secretion of a thick wall around the retracted protoplast. For any given species, the structure and ornamentation of the special wall surrounding these bodies are identical with those of the walls of zygospores of the species. In certain cases, these bodies obviously result from failure of the gamete to unite with another gamete and hence are appropriately called parthenospores. In other cases, as in *Zygnemopsis* and certain species of *Mougeotia* and *Spirogyra* these bodies are formed in filaments where conjugation is not taking place. Thus in spite of the morphological similarities between them and zygotes, it is probable that they are asexual in nature and are to be regarded as in the nature of aplanospores."

Fritsch (4) considers any spores formed other than zygospores as parthenospores, he says:

"In *S. mirabilis* (Hass.) Kütz. there is no indication even of the preliminaries of the conjugation process, although Czurda obtained such in cultures; the parthenospores are simply formed by marked contraction and rounding off of the contents of the cells."

Peterschilka (5) refers to the spores in *S. mirabilis* as parthenospores or azygospores, even though he indicates that the formation of these spores without evidence of normal conjugation is characteristic of *S. mirabilis*. Tiffany and Britton (6), and Transeau (7) use the term aplanospores.

The material on which this report is based was collected in every season of the year extending from the spring of 1969 through the winter of 1970. Spore formation was noted in all collections, however, no indication of conjugation was ever observed, therefore, we are considering these spores aplanospores.

Materials and Methods

In the spring of 1969 the junior author of this paper found in a collection which he had made from shallow water along the edge of a stream in Tanglewood Park, Forsyth County, North Carolina, several filaments of *Spirogyra* sp. which showed numerous aplanospores. Subsequent collections made in the same general area in the summer, fall and winter 1969–70 yielded the same species of *Spiro-*

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gyra with aplanospores. While the *Spirogyra* was never abundant in any of the collections, there was always enough to find healthy specimens showing aplanospore formation. This material could be kept in good condition in the laboratory for several weeks. Attempts to grow the alga in unicellular cultures have been unsuccessful. Ripe spores were isolated in small dishes and some stored at 8°C, and others kept at room temperature for germination studies. All drawings were made with the aid of a camera lucida.

Discussion

General description—Asexual spore formation in *Spirogyra* is encountered infrequently by the average botanist, however, some forms of asexual spores have been reported in a fairly large number of species. Randhawa (1) mentions akinetes of *S. farlowii*, and illustrates these with a figure from Kolkwitz and Krieger (8). The same author lists seven species of *Spirogyra* in which conjugation has not been observed, but which produce aplanospores regularly. These are: *S. olmannsii* Huber-Pestalozzi, *S. aplanospora* Randhawa, *S. karnatae* Randhawa, *S. marvilloso* Transeau, and *S. narcissiana* Transeau. He also lists *S. mirabilis* which produces aplanospores regularly, and zygospores rarely. Some additional twenty species which produce both aplanospores and zygospores have been reported (1, 6, 7, 8, 14).

Rosenvinge (9) described a condition in *S. groenlandica*. Rosenvinge where the conjugation tubes were formed but the gametes failed to migrate and fuse, but simply rounded up and formed parthenospores. Klebs (10) was able to induce conjugating *S. varians* (Hass.) Kütz., to produce parthenospores by increasing the sugar content of the medium. The literature is not always clear whether the asexual spores referred to are aplanospores or parthenospores.

S. mirabilis seems to be the one species which forms spores independently of conjugation most often. These have been reported by Wolle (11), Klebs (10), Petit (12), Peterschilka (5), Transeau (7), Kolkwitz and Krieger (8) and Czurda (13). While conjugation seems to occur rarely in this species, it has been reported a number of times (6, 7, 13, 14).

The description of *S. mirabilis* varies somewhat from one author to another. The diameter given for the cells is fairly constant, 23–29 μ , however, the length given ranges from less than 100 μ to 300 μ ; the description of the chloroplasts and the number of spirals within the cell are other points of differences. There is general agreement that the spores are ovoid to elliptical, and that the spore walls are smooth and thick. Furthermore, all seem to agree that the spores—be they aplanospores, parthenospores (azygospores), or zygospores are morphologically identical. Kolkwitz and Krieger (8) mention and show a longitudinal fissure in the spores which they say occurs frequently. We have not observed any such fissure in our material. Prescott (14) describes the zygospores as 24–29 μ in diameter, 50–83 μ long; Tiffany and Britton

(6) state: "aplanospores (rarely zygospores) are 24–29 μ \times 50–83 μ , ovoid less frequently varying to ellipsoid." Peterschilka (5) describes ripe parthenospores (aplanospores) as more or less long-elliptic, seldom round 20.25–33.75 μ long. The phrase *seltend rund* used by him is the only suggestion which we have been able to find that the spores are ever anything but ovoid or ellipsoid. The mature spores found in all of our material have all been perfectly spherical, (Pl. I, Fig. 3; Pl. II, Fig. 2 and 3). Only when the spores begin to germinate do they become elongated. The diameter of the spores which we have studied is from 30–35 μ , which is slightly greater than the figures generally given for *S. mirabilis*.

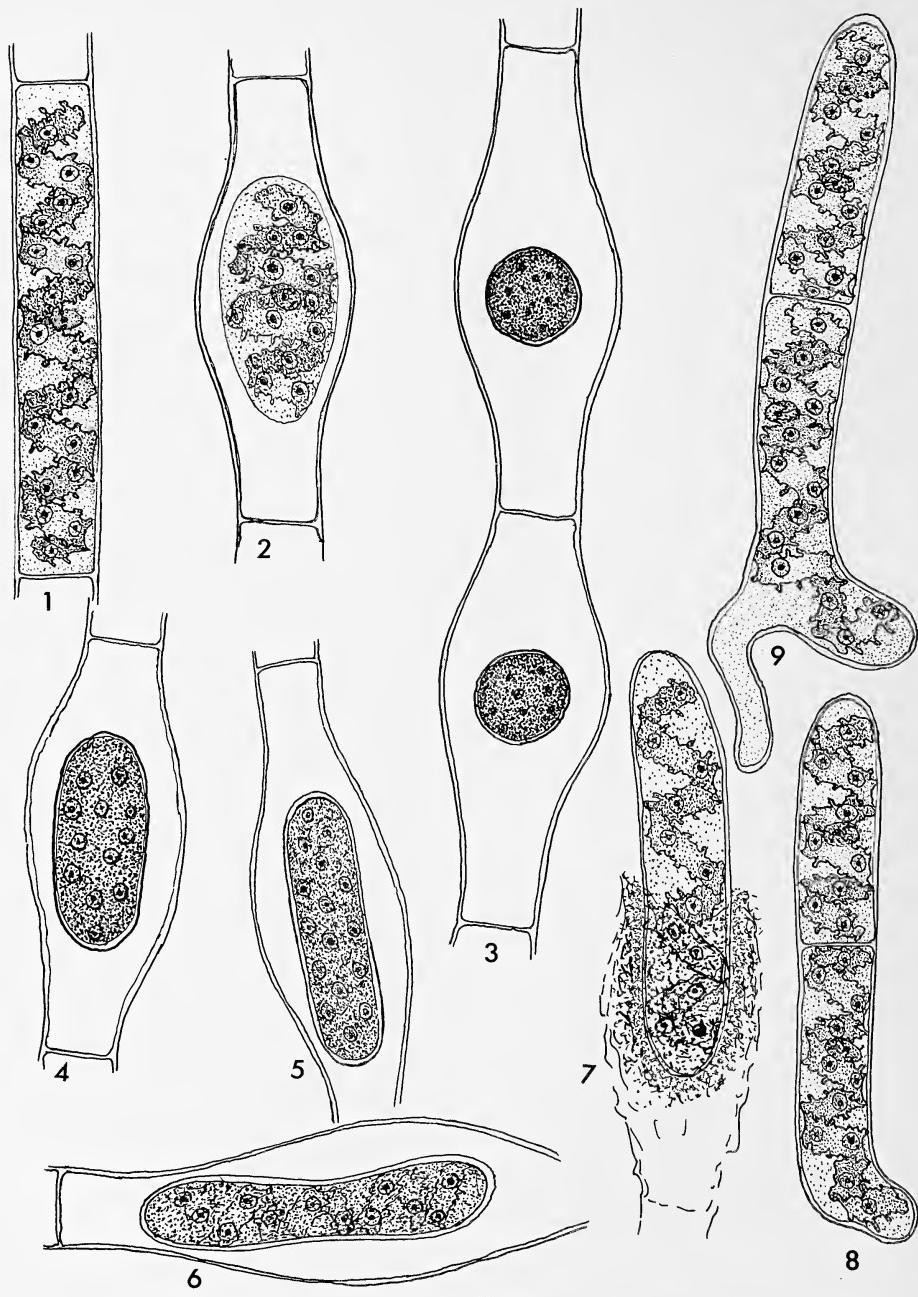
Allowing for minor size variations, the *Spirogyra* with which this paper is concerned fits reasonably well the description of *S. mirabilis*, with the exception of the shape of the spores—ours are definitely spherical rather than ovoid or elliptic. The following is a description of the *Spirogyra* with which we are dealing:

Filaments cylindrical; cells with plane end walls, 28 μ in diameter, 70–120 μ long; chloroplast single, broad, very jagged along the margins, making 5–7 spirals within the cell; pyrenoids large, 7–9 μ ; nucleus central; cytoplasmic strands supporting the nucleus inconspicuous; aplanospores spherical, 30–35 μ in diameter, common, conjugation not observed. Sparse in shallow water, (Pl. I, Fig. 1 and 3; Pl. II, Fig. 1 and 3).

Aplanospore formation—Numerous adjacent cells of a filament tend to form spores more or less simultaneously. The first evidence of spore formation is the conspicuous inflation of the cells near the middle. This is accompanied by a contraction of the protoplasts, first into ovoid masses, which soon become compact and spherical. This is followed by the secretion of moderately thick, smooth double spore walls (Pl. I, Fig. 2 and 3; Pl. II, Fig. 2 and 3).

Aplanospore germination—Spores taken from collections made in the colder months (November–April) usually began to germinate in the laboratory at room temperature within two or three days. During the warmer months less evidence of germination was noted. However, when cultures were stored at 8°C for about three weeks, a definite increase in per cent of germination was noted. Ripe spores formed in the laboratory were separated into two lots. One lot was stored at 8°C for three weeks, the other lot left at room temperature for the same period of time. When the spores which had been kept at 8°C were returned to room temperature, good germination occurred within two or three days, while the controls which had been kept at room temperature showed almost no germination for several weeks. From these observations it seems that the aplanospores of *Spirogyra* sp. go through a short period of dormancy and that exposure to low temperature (8°C) enhances germination.

Spore germination appears to be accomplished by a general softening of the entire spore wall



X480

PLATE I—Camera lucida drawings of aplanospore formation and germination in *Spirogyra* sp. FIG. 1—Vegetative cell. FIG. 2—Beginning of aplanospore formation. FIG. 3—Mature aplanospores. FIG. 4, 5 and 6—Germination of aplanospores. FIG. 7—One-celled sporeling. FIG. 8 and 9—Sporelings showing rhizoid-like basal cell. All figures X 480.

PLATE II

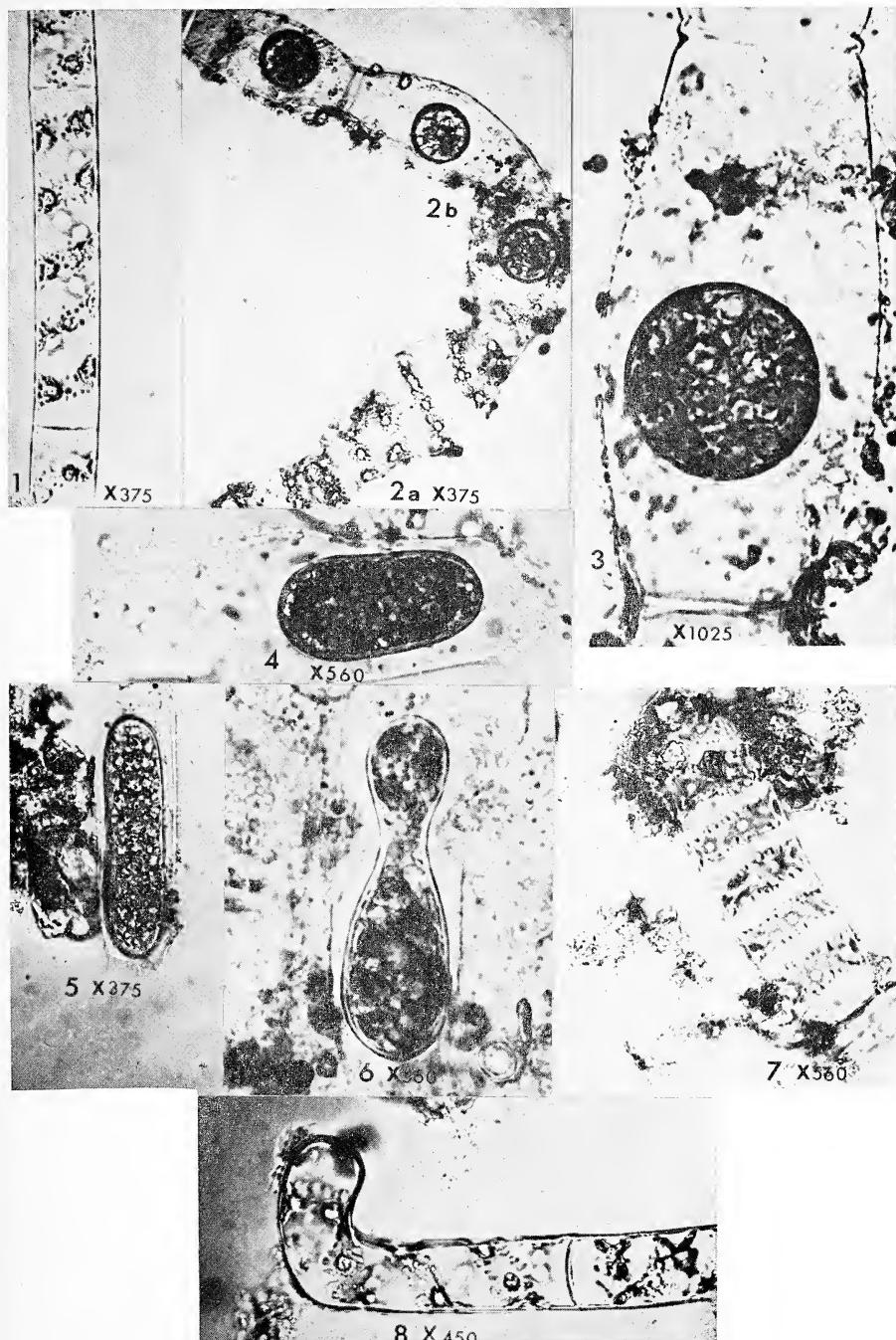


PLATE II—Photomicrographs of aplanospore formation and germination of *Spirogyra* sp. FIG. 1—Vegetative cell, X 375. FIG. 2a—Beginning of aplanospore formation, X 375. FIG. 2b—Mature aplanospores, X 375. FIG. 3—Mature aplanospore, X 1025. FIG. 4—Beginning of germination of aplanospore, X 375. FIG. 5—Evidence of chloroplast in germinating aplanospore, X 375. FIG. 6—Hourglass-shaped germinating aplanospore, X 560. FIG. 7—One-celled sporeling, X 560. FIG. 8—Sporeling showing curved basal cell, X 450.

rather than a break or softening at a single point, as shown by Fritsch (4). As the wall softens the protoplast absorbs water and begins to elongate, (Pl. I, Fig. 4 and 5; Pl. II, Fig. 4 and 5). Soon thereafter the chloroplasts with pyrenoids become evident. Frequently the protoplast becomes somewhat hourglass-shaped at this time, (Pl. II, Fig. 6). The old spore wall disappears or becomes sloughed off as an amorphous slimy mass, (Pl. II, Fig. 7). The time required to complete the germination process at room temperature is about 12 hours.

In the development of the sporelings from the one cell stage, the cell divides and the basal cell frequently becomes curved and forms a rhizoid-like structure, (Pl. I, Fig. 8 and 9; Pl. II, Fig. 8). Division of the basal, rhizoid-like cell has not been observed; however, division of the distal cell and cells arising from it occurs in the regular manner.

While aplanospores have been observed many times and these observations recorded, discussions of the germination of these spores is conspicuously wanting in the literature.

Summary

The formation of aplanospores in an undetermined species of *Spirogyra*, and the germination of these spores has been observed and studied over a period of about twelve months. The results of these studies have been described in this paper. The *Spirogyra* which has been studied resembles *S. mirabilis* in a number of ways, but differs from it very definitely in the size and shape of the spores. *S. mirabilis* is one of the less common species. Whitford and Schumacher (15) do not include it in their recent book on the fresh-water algae of North Carolina, nor have we found any record of it from the state.

The question of whether the species described here should be considered a variant of *S. mirabilis* or a new species has not been resolved.

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A Synopsis of the *Culicoides* (Diptera: Ceratopogonidae) of West Virginia with New State Records

Abstract—The collection of 6 *Culicoides* species new for West Virginia is reported, and their breeding sites are described. Records of 5 additional species occurring in the state are published for the first time, and a list of the *Culicoides* of West Virginia is given.

Introduction

While conducting field work in preparation of a monograph on the *Culicoides* (Diptera: Ceratopogonidae) of Virginia, the authors had occasion to sample suspected breeding sites in southern West Virginia. This paper presents the results of those collections, plus a synopsis of the *Culicoides* spp. known from West Virginia. The relative importance of this group has been discussed in a previous paper (1).

The authors wish to acknowledge the following: Dr. Willis W. Wirth, for permitting us to examine the collection at the U. S. National Museum for unpublished records; Mr. James O. Howell, for assisting with the collecting; Mrs. Martha Farley, for technical assistance; and the Entomology Research Division, A.R.S., U.S.D.A., for providing financial assistance in the form of grant no. 12-14-100-9127(33).

Procedure

The collecting and rearing procedures have been described previously (1). All collections in the present study consisted of 500 ml of breeding substrate and were taken on June 9, 1969.

Results and Discussion

The breeding sites which yielded *Culicoides* in the present study are described below by collection number:

Coll. 104—Mud among weeds and rocks at edge of swift, clear stream; Waiteville, Monroe County.
Coll. 106—Leaf litter in channel of small mountain stream; 3 mi. N. of Waiteville, Monroe Co. *Coll. 107*—Mud at edge of farm pond; 2 mi. S. of Gap Mills, Monroe Co. *Coll. 108*—Mud at edge of farm pond; 5 mi. W. of Gap Mills, Monroe Co. *Coll. 110*—Mud at edge of farm pond; 1 mi. S.E. of Pickaway, Monroe Co. *Coll. 112*—Sandy, heavily polluted mud at edge of Broad Run; W.

Va. 3, 5 mi. W. of Sinks Grove, Monroe Co. *Coll. 113*—Sandy, stagnant mud at edge of swift, clear stream in deep wooded ravine; W. Va. 3, Alderson, Greenbrier Co. *Coll. 114*—Sand and leaf litter, edge of swift stream in deep wooded ravine; W. Va. 20, 11 mi. S. of Hinton, Summers Co.

Culicoides baueri Hoffman

New Records from this Study: Coll. 112 (2 females).

Previous Records: not known from West Virginia prior to the present study.

C. crepuscularis Malloch

New Records from this Study: Coll. 107 (7 males, 6 females); Coll. 108 (1 male, 1 female); Coll. 112 (1 male, 2 females).

Previous Records: not known from West Virginia prior to the present study.

C. haematopotus Malloch

New Records from this Study: Coll. 104 (1 female); Coll. 107 (2 females); Coll. 112 (16 males, 9 females); Coll. 113 (8 males, 8 females).

Previous Records: not known from West Virginia prior to the present study.

C. piliferus "group" *sensu* Wirth and Hubert

New Records from this Study: Coll. 106 (1 male). Males of this group cannot be determined to the species level without benefit of associated females (4).

C. spinosus Root and Hoffman

New Records from this Study: Coll. 114 (3 males, 4 females).

Previous Records: Cranberry Glades (2).

C. stellifer (Coquillett)

New Records from this Study: Coll. 112 (1 male, 3 females).

Previous Records: not known from West Virginia prior to the present study.

C. travisi Vargas

New Records from this Study: Coll. 106 (1 male).

Previous Records: There are no earlier reports in the literature of this species occurring in West Virginia. There is an unpublished record (3) of *travisi* from the Cranberry River.

C. variipennis (Coquillett)

New Records from this Study: Coll. 108 (11 males, 6 females); Coll. 110 (2 males, 9 females). *Previous Records:* not known from West Virginia prior to the present study.

Summary

In addition to the 7 species covered in this paper, the following *Culicoides* had been previously collected in West Virginia: *C. bickleyi* Wirth and Hubert: Cranberry Glades (4). *C. biguttatus* (Coquillett): Cranberry Glades (5). *C. dickei* Jones: Cranberry Glades (3). *C. loisae* Jamnback: Cranberry River (2). *C. mulrennani* Beck: Cranberry Glades (3). *C. nanus* Root and Hoffman: no location given (6). *C. obsoletus* (Meigen): Cranberry Glades (7). *C. paraensis*

(Goeldi): Capon Springs (3). *C. piliferus* Root and Hoffman: Cranberry Glades (5). *C. sanguisuga* (Coquillett): Allegheny Mtns., Cranberry Glades, Lost River State Park (7); Monroe Co. (8). *C. snowi* Wirth and Jones: Lost River State Park (4). There are now 18 *Culicoides* spp. known from West Virginia.

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A Biophysical Magnetometer-Gradiometer*

Abstract—The human body seems to be able to detect minute magnetic field gradient changes. If an interaction of a magnetic field with the human body occurs, a slight twist of the forearms is observed and can be amplified by a simple mechanical device, the dowsing rod. The sensitivity of man to magnetic fields can be determined by exposing subjects to magnetic fields produced by electric currents (AC or DC) of varying intensities passing through damp ground. The lower the intensity of the current, thus of the magnetic field, required to produce reaction of the subject the greater is his sensitivity to magnetic field changes. A reaction is observed only when the negative electrode is at the left (heart) side of the subject. About 80% of the subjects tested showed a pronounced sensitivity toward magnetic field changes. Some applications of this biophysical phenomenon are discussed.

S. W. Tromp (1) and Y. Rocard (2) in their books seem to consider dowsing a phenomenon worthwhile for scientific consideration and scrutiny and are inclined to explain dowsing as a manifestation of interactions of many energy forms externally applied to the human body, with the major contribution being magnetic ones. From the literature (1, 2, 3) one can see that there are many people who have the ability to manipulate the dowsing rods successfully.

According to the author's experience almost 80% of individuals exposed to the manipulation of dowsing rods of the type reported by Budgett in 1935 (4), showed some ability to obtain signals, while less than 20% were successful when the forked twig was used. This experience suggested use of the dowsing rods. The dowsing rods mentioned consist of 2 L-shaped rods or wires 2–4 mm in diameter, the longer part being about 60–80 cm long, while the shorter one is 15 cm in length. The shorter part of the L-shaped rod is handheld so that the longer part can swing freely around a horizontal axis (being the shorter part). To reduce friction the shorter part of the dowsing rods is put into a tubing as a bearing. The dowser holds in each hand one of the L-shaped rods and adjusts them by twisting the arm so that they are parallel in the horizontal plane. Appropriate twist of the arms to parallel alignments of the rods can produce convergence or divergence of the rods to indicate a signal. The use of 2 rods is preferable to one rod

only because convergence or divergence is easier to detect. An increase of the depression angle of the longer part of the L-shaped rods in the vertical plane reduces the reaction sensitivity of the dowser. A depression angle of $1^\circ - 5^\circ$ renders good sensitivity and also satisfactory stability of the rods when they converge or diverge indicating a signal.

The material of the L-shaped rods and of the bearing tube does not influence the performance of the dowser. The dowsing rods indicate the twist of the arms only. The twist of the arms is the result of an interaction of external energy forms (magnetic field changes) with the human body. All experiments were done, and data reported below were obtained, by using these rods.

A dowser will be successful, the more he is able to detach himself emotionally from the dowsing activity or from any other "exciting" thoughts. Signals are observed when the dowser moves by walking, by being driven in a car, or by sitting in a moving airplane. He also is able to observe a signal if he is exposed to a moving Alnico magnet or an electromagnet, or by a stationary electromagnet while the energizing current is increased. This author noted however, that the convergence (or divergence) of the rods indicating the signal does not occur while the magnetic field is decreasing. However, when he is walking or making the leg motion of walking, the null adjustment (to parallel rods) is obtained when the magnetic field fades. A fairly sensitive dowser is able to react to magnetic field changes of 0.1 gamma/second or less.

Experiments performed by the author have shown that when a direct current passes through the ground a dowsing signal is obtained only when the negative pole is on the left (heart) side of the dowser. It would be interesting to use a subject having a *situs inversus* as a dowser in this experiment. Would this subject react only if the negative electrode is on his right side? If he walks parallel to the direction of the current (toward or away from the negative pole) he obtains a signal. This observation suggests a directivity of the phenomenon, thus excluding Rocard's (2) explanation of dowsing by proton resonance of some constituents of the human body. When alternating current is used, no directionality is observed.

Using the intensity of a direct current passing

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through the ground between 2 electrodes separated at least 10 meters from each other, this author was able to determine quantitatively the sensitivity of a dowser toward a magnetic disturbance. Most of the subjects tested (60%) showed an incipient signal when the current was about 35–50 mA. A good dowser shows a signal at 10–20 mA while only a very few react to currents of 0.5–10 mA. By appropriate training the sensitivity can be increased (from 40 mA to 10 mA). Assuming that the location of the interaction of the human body with the magnetic field is in the vicinity of the thorax (approximately 1.5 meters above the ground) the magnetic field intensity above the current path is then approximately 0.1 gamma at 20 mA current intensity. Thus traversing the magnetic field produced by the current of 20 mA with a walking speed of 2 m/sec a field change of 0.03 gamma in the vicinity of the field apex (maximum) would cause a signal from a dowser of average skill and aptitude (15%). Skilled dowsers of above average aptitudes (4%) react to 2 mA currents (0.003 gamma) and exceptional ones (1%) to 0.5 mA or less (0.0007 gamma).

Brain waves (5) and heart currents (6) of man were observed and measured with high-sensitivity magnetometers and recorders. This author attempted successfully to detect these currents (and thus the associated magnetic fields) utilizing the dowsing rods. The subject to be tested was placed in varying distances, back to back, to the dowser and was asked to think of something very exciting. He also was asked to start thinking not immediately after this instruction was given, but after a time of his choosing. The dowser announced the reaction to the subject. Thus, the subject was able to determine the instant at which the dowser reacted to his thoughts. The closest distance of the subject to the dowser was 2 feet. Some persons were able to produce reaction of the dowser even at 16 to 20 feet.

The strongest magnetic emissions from the subject were produced by sex-related "exciting" thoughts and thoughts of fear. Positioning of the subject (back to back, left or right side to back, front to back of dowser) relative to the dowser did not show any significant change in the signal intensity displayed by the dowser. All 28 subjects (19 males and 9 females) did cause reactions of the dowser although some were weaker than others. Subjects with high blood pressure seemed to pro-

duce stronger magnetic fields than those of normal or low blood pressure.

It should be mentioned that dowsing reactions could be observed by the dowser when he himself is thinking of "exciting" things while dowsing. This observation of the author suggests the necessity of psychological detachment of the dowser to avoid spurious reactions. It also could explain why some dowsers are not too successful when they demonstrate their skills in presence of an audience.

The above described experiments suggest strongly that man possesses the ability to sense weak magnetic field gradient changes which are indicated by skillful manipulation of dowsing rods. Thus, the dowser can determine the location of a magnetic disturbance, and in some cases perhaps the depth or height of the location of the origin of the disturbance. This magnetic interpretation could explain why the dowser is able to locate flowing water (unpaired moving ions), buried objects, including rocks, cavities (caves, tunnels) tree and vine root systems, culverts, overhead wires, and magnetic fields emanating from persons, especially when they are excited.

The dowser probably cannot determine the causes of the magnetic disturbance (buried metals, ores, rocks, flowing water, cavities, people). He only is able to observe a magnetic disturbance. Since the dowser reacts to magnetic field gradient changes only, the absolute magnitude of the ambient magnetic field has no influence on the performance of the dowser and on the appearance of a dowsing signal. This fact may facilitate the search for the biophysical principles upon which the dowsing mechanism is based.

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A Reevaluation of the Length-Difficulty Relationship

Abstract—Task difficulty was assessed when task length was varied and when task length was confounded by changes in the nature of the task. A trend analysis revealed that task difficulty increased at a disproportionately faster rate when length and nature of the task were confounded, but only linearly when task length was varied.

Introduction

Early experimenters who investigated the relationship between task length and task difficulty generally found that time increased at a rate which was disproportionately faster than the increase in the amount of material. Lyon (1) studied the time taken to learn various numbers of syllables and prose words, and he found a positively accelerated relationship between time to learn and number to learn. For example, a *S* requiring 2.25 minutes to learn 50 prose words took almost four times that long to learn 100 words. Scott and Henninger (2) found the same relation to hold for learning of the finger maze as the number of choice points was increased.

However, the positively accelerated function found in the earlier studies might have been due to some qualitative changes in different aspects of the nature of the task as the length was increased. The present experiment was designed to analyze the effect of task length alone, holding task nature constant. It was hypothesized that if the only variable was task length, then the relation between difficulty and length would be essentially linear.

Method

Forty introductory psychology students at the University of Richmond were systematically divided into two groups so that each contained twelve females and eight males. Each group was then broken down into an ascending and a descending group, each of which contained six females and four males.

The apparatus was a card-sort apparatus containing three rows of five boxes each (Lafayette Instrument Co.). The numbers 1 to 15 were stamped on three removable strips which could be shifted around from top, middle, or bottom as desired. The cards consisted of 3 × 2 inch paperboard, with numbers printed in black on one side.

One group was designated as the Task-Length Group (TL) and the other as the Length Group (L). The *Ss* were handed decks of cards of varying sizes, with the numbers face down. At the *E*'s signal, *Ss* were instructed to turn the cards over one at a time and to sort them into the appropriately numbered boxes. The *Ss* were further instructed that should they accidentally drop a card into the wrong box or onto the floor, they were not to attempt to retrieve it, but to continue working as rapidly as possible. Each group received seven trials either starting with 70 cards and ending with 10 in the descending condition, or starting with 10 and ending with 70 in the ascending condition.

Group TL (ascending) started with two sets of five cards bearing the same number (i.e., one set consisted of five 1's, another of five 4's, etc.), the numbers being selected in a random manner from 1 to 15 (except number 9). The deck was increased on each trial by the addition of two more sets, selected at random, until on trial seven, 14 sets, or 70 cards were used. The procedure for Group TL allowed for the manipulation of both task length (number of cards) and task nature (the addition of different numbers). The descending group received the same treatment, except that they started with 14 sets and on each subsequent trial two sets were removed. Two minutes were allowed between trials, and the *Ss* were instructed to face away from the apparatus during the intertrial interval. The counter-balancing procedure of ascending and descending series equally distributed the effect of learning and/or fatigue over all seven points within each group.

Group L received essentially the same treatment as Group TL, except that on trial one, ascending, the *S* had 10 cards consisting of two each of five different numbers (i.e., two 1's, two 3's, two 14's, two 5's, two 8's, etc.). On each subsequent trial the *S* used two more cards on each number so that he used the same number of cards on each trial as did Group TL. A table of random numbers was used to assure that all of the 14 numbers were used at least once during the experiment. The *Ss* were timed to the nearest second on each trial, and the pooled data for the ascending and descending treatments for each group were used in analyzing the results.

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Results

Results from the L and the TL conditions are shown in Fig. 1. Inspection reveals that the curve for the TL Group appears to show the familiar positively accelerated shape, while the curve for the L Group is essentially linear.

An analysis of variance for repeated measures across seven trials revealed a significant trials main effect for the TL Group [$F(6, 114) = 502.62, p < .01$]. Furthermore, a trend analysis revealed a significant linear component [$F(1, 114) = 2983.18, p < .01$], and deviation from linearity was also significant [$F(5, 114) = 6.50, p < .01$]. The same analysis for the L Group revealed identical findings. There was a significant trials main effect [$F(6, 114) = 400.85, p < .01$] which contained a significant linear component [$F(1, 114) = 118.58, p < .01$] and significant deviation from linearity [$F(5, 114) = 232.51, p < .01$].

In view of the above findings which indicated that there was no difference between the slopes of the TL and L Groups, an additional analysis was pursued. It was decided to drop the seventh trial for both TL and L Groups and perform an analysis of trend. The rationale for the omission of the seventh

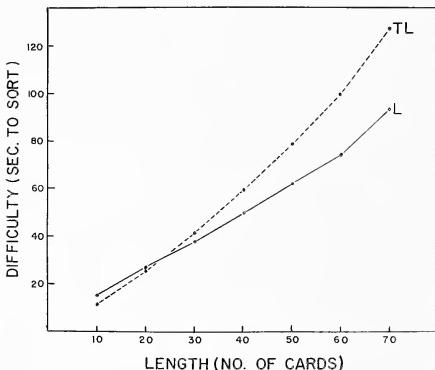


FIG. 1.—The relationship between time to sort cards and number of cards to sort when task nature and task length covary (Group TL) and when only task length varies (Group L).

trial is provided in the discussion section. At any rate, with six trials there is a significant trials main effect [$F(5, 95) = 587.58, p < .01$] for the TL Group accompanied by a significant linear trend [$F(1, 95) = 2923.34, p < .01$] and significant deviation from linearity [$F(4, 95) = 3.63, p < .01$]. However, for the L Group at six trials, the trials main effect was significant [$F(5, 95) = 813.76, p < .01$] and the linear trend was significant [$F(1, 95) = 4066.00, p < .01$], but deviation from linearity was not significant [$F(4, 95) = <1$]. Additional support for the original prediction of different slopes for the TL and L Groups was found in an analysis of variance comparing the performance of two groups over all seven trials. The interaction term from such an analysis was significant [$F(6, 228) = 36.73, p < .01$].

Discussion

Contrary to prediction, both the TL Group and the L Group showed a curvilinear relationship between task difficulty and seven task lengths. The prediction of a linear relationship for Group L is confirmed for only six task lengths, and the following is an attempt to explain what could have happened at the seventh task length. It appears that the E may have inadvertently introduced an extraneous variable to the task on the seventh trial. The seventh trial involved the handling of a deck of 70 cards which may have been awkward and cumbersome for the Ss, thereby artificially inflating time to sort on this particular trial. The relationship shown in Fig. 1 reveals a sharp upward acceleration for both groups from trial 6 to 7. Also, when the experiment was later described to the Ss, many admitted to having difficulty in manipulating the 70 card deck. Therefore, the E justified in dropping the seventh trial for both groups.

The results for six task lengths clearly demonstrate that, when task nature is held constant, difficulty increases in a linear fashion with task length. The present investigation implies that the earlier experiments, which found that task difficulty increased at a disproportionately faster rate than task length, varied not only the length of the task but the nature of the task.

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An Obscured Milestone in the History of Bioenergetics and Oxidative Phosphorylation

We recognize life as we do the wind, the atom, or the Deity—by its signs. The signs of the living state are motion, neural activity, secretion, proliferation, and so on. These in turn are in reality energy transformations which include transduction of chemical energy into mechanical, electrical and osmotic work. Energy in living cells is liberated, conserved, transformed and utilized in a complexity of interdigitated reaction chains. The ingenious and diligent labors of many investigators over the years have culminated in a reasonably clear understanding of energy metabolism which in its detail is unsurpassed by any other branch of contemporary biochemistry. However, the mechanism of none of these transformations is fully comprehended. They constitute the most exciting and fundamental problems of the life sciences.

The experimental literature on electron transport, oxidative phosphorylation, and the dynamics of mitochondrial reactions has been growing enormously in both volume and intricacy as this field attracts increasing numbers of investigators. The pioneering contributions of giants in biochemistry twenty and thirty years ago are well commemorated and their significance deferentially cultivated. However, the formidable work of Vladimir A. Belitzer in the late 1930's lies in jeopardy of full recognition and in danger of loss by obscurity to Western science (conceivably because of its publication in the Russian literature principally). The observations of Belitzer and his colleagues, and his perceptive interpretations of them, were pregnant with precedents which contributed to the *épanouissement* of research in this area during the past fifteen years. It is the purpose of this communication to disseminate more widely the critical experiments of Belitzer in order that another generation of life scientists may more properly appreciate its liability to his remarkable insight.

Even beginning students today are aware that oxidation-reduction energy of electron transport is transformed into osmotic energy (ion translocation) and into mechanical energy (swelling-contraction cycles) within the mitochondrion; furthermore, the aerobic generation of adenosine triphosphate (ATP)

from adenosine diphosphate (ADP) and inorganic orthophosphate (P_i) by energy coupling in the respiratory chain is the final step in cellular respiration, for which the citric acid and fatty acid oxidation cycles are essentially preparatory processes. The major fate of respiratory energy is its conservation as chemical energy in ATP with a thermodynamic efficiency of more than 50%.

Recognition of the existence of these phenomena commenced in 1930 when Englehardt (1, 2) perceived a relation between P_i esterification and respiration. Subsequently Kalckar (3–5) showed that aerobic phosphorylation was clearly related to respiration and was independent of glycolytic phosphorylation. He was led to that conclusion by the equal inhibition of both respiration and P_i esterification by cyanide, and by the equal stimulation of both processes by substances such as alanine, glutamate, citrate, malate or fumarate.

The first systematic, quantitative evaluation of the phenomenon, however, was undertaken by Belitzer and Tzibakova (6). They were the first to define in stoichiometric terms the coupling of P_i esterification to electron transfer in the respiratory chain and to postulate that the energy of electron transport from substrate to oxygen was the probable source of the energy required to generate the two or more molecules of ATP which were observed to be formed per atom of oxygen consumed. Although not employing today's terminology, they introduced such concepts as the P/O ratio, respiratory control (acceptor control of respiration), uncoupling, tight and loose coupling, and nonphosphorylating oxidation. Moreover, they inaugurated investigation into the mechanism of respiratory phosphorylation by attempting to localize coupling sites through use of various substrates and inhibitors.

Phosphagen Synthesis during Respiration

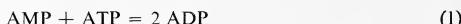
It had already been established that the synthesis of ATP and creatine phosphate could occur in muscle via glycolytic energy and, furthermore, that formation of glycolytic phosphate esters was accompanied by oxidoreduction between phosphotriose and codehydrogenase I (nicotinamide ade-

nine dinucleotide, NAD). Therefore, the Russian workers felt justified in assuming that in respiration, as in glycolysis, phosphorylation was connected with oxidoreduction, possibly also involving NAD. There were, in fact, indirect data which suggested that oxidations not related to glycolysis could lead to phosphorylations. They cited, for example, Braunein's and Severin's observations that oxidation of pyruvate, α -ketoglutarate or alanine stabilized ATP in nucleated erythrocytes and the earlier work of Meyerhof and others that lactate, pyruvate or succinate stabilized the phosphagen (creatine phosphate) of iodoacetate-poisoned muscle. For these and similar reasons, Belitzer and Tzibakova propounded the existence of a "purely respiratory" synthesis of phosphagen. Such a proposal of course was not in accord with Meyerhof's view (7) which considered oxidation of phosphotriose with cozymase as the only oxidoreduction coupled to the esterification of P_i .

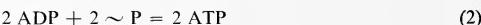
Moreover, Belitzer in a previous report (8) had observed that coupling between respiration and phosphorylation of creatine was maintained only under conditions of integrity of a certain factor, probably of enzymic nature, present in the tissue and very easily destroyed, either by very fine grinding, or by exposure of the tissue to distilled water. Elimination of that factor did not depress the intensity of respiration but was manifested only in suppression of phosphagen synthesis. (Here was the first description of classical "uncoupling.") In addition, he could affirm that products of phosphagen cleavage function as activators of respiration in muscle:

A l'heure qu'il est, tout ce qu'on peut dire à propos de l'effet de la créatine sur la respiration c'est que son action est due à sa capacité de servir d'accepteur pour le groupe phosphorique.

Adenylate kinase:



Oxidative phosphorylation:



Creatine phosphokinase:



Overall:



That is to say, in muscle, control of the intensity of respiration was perceived to be primarily a function of the availability of P_i acceptors, especially creatine. (Here was the first description of the phenomenon of respiratory control.) Neither creatine

phosphate nor creatinine augmented respiration.

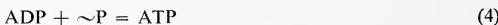
In preliminary experiments designed to establish the existence of respiratory chain phosphorylation, Belitzer and Tzibakova followed phosphagen synthesis under various conditions during oxidation of substrates such as lactate, malate, pyruvate, citrate, fumarate, α -ketoglutarate and succinate by washed minces of pigeon breast muscle and rabbit heart. Supplementation with oxygen and substrate was the *sine qua non* for phosphagen formation by these preparations, while lack of either negated its synthesis. Metabolites were oxidized completely to CO_2 and H_2O during phosphagen formation and hence the latter process was clearly associated with respiration (rather than glycolysis).

Realizing that during glycolysis phosphagen is the secondary P_i acceptor, after initial phosphorylation of the adenylate system, they looked for a similar metabolic transfer during respiratory phosphorylation in the presence of iodoacetate to arrest glycolysis. Not only was adenylic acid (AMP) rapidly phosphorylated on addition of substrate, but substrate oxidation was markedly stimulated by AMP addition. The increased respiration lasted only 10–20 minutes, but when creatine was also added, the stimulated respiration was prolonged substantially and phosphagen synthesized corresponded to P_i which disappeared. Thus was observed the first quantitative evidence of the phenomenon of respiratory control—the control of respiration by P_i acceptor. In retrospect, the participation of adenosine diphosphate (ADP), the actual acceptor control agent, may be explained as arising via adenylate kinase in the tissue preparations.

Their experiments also showed the value of an "ATP trap" in prolonged studies of respiratory phosphorylation since creatine, via the creatine phosphokinase reaction provided for regeneration of the initial P_i acceptor, ADP (reaction 3), and pre-

vented its depletion as a consequence of ATP formation (reaction 2). In a subsequent paper (9) Belitzer reported even more efficient ATP traps than creatine-creatinine phosphokinase, including the preferred glucose-hexokinase system:

Oxidative phosphorylation:



Hexokinase:



Overall:



In such a trapping system, ADP was again regenerated (reaction 5) rather than being depleted by the phosphorylation process (reaction 4).

Effect of Various Inhibitors on Respiratory Phosphorylation

Belitzer and Tzibakova showed that in addition to iodoacetate and bromoacetate, other glycolytic inhibitors such as fluoride and oxalate, which react with the Mg-enzyme enolase, arrested glycolytic phosphagen synthesis, but did not inhibit aerobic or respiratory phosphorylation. In fact, they observed that considerably less oxygen was required for an equivalent amount of phosphagen formation in the presence of fluoride and they hypothesized that the "increased effectiveness of respiration" with NaF was probably not due to an actual increase in phosphorylation, but rather to an inhibition of dephosphorylation, preventing loss of the phosphorylated product. Again Belitzer's incisive insight was confirmed when the Mg-activated ATPase of mitochondria was discovered. Thus, inclusion of fluoride ion became an important and useful tool in subsequent studies of respiratory phosphorylation in tissue homogenates and crude mitochondrial preparations in that it prevented artificially low phosphorylation values due to Mg-ATPase activity, as well as artificially high values due to glycolytic phosphorylation.

A new phenomenon appeared to Belitzer and Tzibakova when they observed that arsenate inhibited phosphagen synthesis while frequently stimulating respiration. They suggested that this "...heightening of respiration due to arsenate, apparently based on the inhibition of phosphorylation, could be manifested only if the velocity of respiration is limited by the phosphorylation process." This prophetic reference to loss of respiratory control and stimulation of respiration by certain agents (uncouplers) presaged subsequent recognition of the phenomenon of uncoupling and the mode of action of arsenate which, by competing with orthophosphate, results in discharge of the initial high energy intermediate of oxidative phosphorylation, thereby preventing the ensuing phosphorylation of ADP. Arsenite, on the other hand, unlike arsenate, inhibited respiration and the associated phosphorylation with substrates such as lactate, malate, fumarate, citrate, and α -ketoglutarate by reacting, as is now known, with the lipoyl site of the α -ketoacid decarboxylases.

Efficiency of Respiratory Phosphorylation

As mentioned earlier, Belitzer and Tzibakova achieved the first quantitative evaluation of the relation between oxygen consumption and the synthesis of phosphagen. Their pioneering studies employed unwashed frog skeletal muscle minces with endogenous substrates plus added creatine, Mg^{2+} , KCl and P_i . Oxygen consumption was determined manometrically at 0° and phosphagen was estimated in deproteinized reaction mixtures. From such data they calculated "synthesis ratios":

$$\text{Synthesis ratio} = \frac{\text{moles phosphocreatine synthesized}}{\text{moles oxygen absorbed}}$$

In a variety of experiments (with endogenous metabolites) they found that synthesis ratios lay in the range of 4 to 7. The fact that this range, achieved more than 30 years ago, corresponds to a P/O range of 2 to 3.5 attests to the superior technical capabilities of Belitzer and Tzibakova.

In subsequent experiments they examined phosphagen synthesis associated specifically with the oxidation of succinate. This particular metabolite was of interest in that all previously known oxidoreductions associated with phosphorylation required coenzymes but at that time no evidence of a coenzyme requirement for succinate oxidation had been obtained. They made the interesting observation, however, that with succinate, the synthesis of phosphagen was no greater than with other substrates, but that oxygen consumption was considerably more intense. In other words, the P/O ratio for succinate was lower than that for other substrates. This was the first indication that a different number of coupling sites exist in the chains for electron transport to oxygen from different electron donor substrates. Their measurements convinced them that the limit of efficiency for the oxidation of succinate to fumarate was one mole of phosphagen synthesized per pair of hydrogen atoms transferred. In another series of experiments they investigated the possibility of respiratory phosphorylation in the "iron system" (the cytochromes and the *Atmungsferment* of Warburg). This segment of the respiratory chain was biochemically isolated through the use of *p*-phenylenediamine to reduce cytochrome directly. It is notable that the biochemical dissection of the respiratory chain by use of artificial electron donors and acceptors, in concert with site-specific inhibitors of electron transport, subsequently became a potent tool for investigating the sequential events of electron transport and phosphorylation. Although oxygen uptake was even more rapid with *p*-phenylenediamine than with succinate, no synthesis of phosphagen was detected and hence it was concluded that oxidoreduction in the "iron system" was not associated with phosphorylation. These interpretations may be explained by the likelihood of loss of coupling at phosphorylation site III since this site has been shown to be the most labile and to have the least significance on the overall control of respiration by phosphate acceptor in mitochondria from such diverse sources as beef heart (10) and *Aspergillus niger* (11). Furthermore, loss of coupling at site III in Belitzer's preparations would explain the maximum P/O value of 1 which he obtained for succinate.

However, despite the error in approximating the magnitude of phosphorylation associated with succinate oxidation, it was possible for Belitzer and Tzibakova to estimate with surprising accuracy the efficiency of oxidative phosphorylation. From the heats of combustion, one can calculate that about

110 kcal are liberated per mole of oxygen consumed in the complete oxidation of metabolic fuels. With an average value of 5.5 (range, 4-7) for the synthesis ratio (moles of phosphagen synthesized per mole of oxygen consumed), and a negative Gibbs free

eralization that velocity of respiration is determined by a substance's ability to accept phosphate groups. Of equal significance was their deduction that the continuing metabolic processes transpiring in aerobic, resting muscle were probably regulated by

$$\frac{(5.5 \text{ moles phosphagen/mole O}_2) (11.5 \text{ kcal/mole phosphagen})}{110 \text{ kcal/mole O}_2} \times 100 = 57.5\%$$

energy of hydrolysis for the phosphamide bond of creatine phosphate equal to 11.5 kcal per mole, the total respiratory energy retained as phosphagen is 63.25 kcal per mole of oxygen. This represents an efficiency of 57.5%.

It is noteworthy that this value is practically identical to the efficiency of oxidative phosphorylation associated with various metabolites as determined by modern techniques with isolated mitochondria or phosphorylating electron transport particles.

Similarly, they recognized that phosphagen synthesis via respiratory phosphorylation vastly exceeded that from glycolysis and that the mechanisms of respiratory phosphorylation and of cellular respiration were closely related. They emphasized, for example, that the complete oxidation of a hexose molecule consisted of 12 individual dehydrogenation steps and consequently each of 12 pairs of hydrogen atoms were transferred via a series of intermediate redox carriers to oxygen. Therefore, the high coefficients of respiratory phosphorylation as well as the thermodynamic efficiency were a reflection of the fact that not only primary, but also some of the intermediary oxidoreductions were connected with phosphorylation. That is to say, in addition to the initial oxidoreduction of metabolite and dehydrogenase, two or more further oxidoreductions involved in electron transport were also associated with phosphorylation.

Conclusion

These investigations of Belitzer and Tzibakova, which represent a benchmark of elegance and directness, and a milestone in the chronology of the exciting history of bioenergetics, identified for the first time the fundamental nature of the phenomena of coupling and uncoupling, and differentiated the processes of oxidative phosphorylation from substrate level phosphorylation. Of particular import was their demonstration that respiration of muscle mince was stimulated by added creatine, which was concurrently converted to creatine phosphate. Respiration was also stimulated by adenylic acid or by glucose plus hexokinase. Thus emerged the gen-

cleavage of ATP and by the respiratory resynthesis of that substance. These two observations defined the vitally important phenomenon which was later to be designated "respiratory control" (12) and which, simplistically, represents a feedback control wherein the rate of metabolite combustion is regulated or modulated by cellular energy demand.

All of these contributions to knowledge, applicable to all tissues which contain mitochondria, were obtained with crude muscle minces in an era predating the development of techniques for cell fractionation and investigations with isolated, functionally intact mitochondria. In attempting to comprehend the relation of respiration to phosphorylation today, we have considerably more information than that which was available to Kalckar, Belitzer and their co-pioneers. New data have, in their turn, raised new questions, and solutions to the basic questions are far from complete. Nevertheless, impelled by classical, trail blazing discoveries such as those cited, the scientific disclosures and data accumulated over the past two decades have continued apace and permit exploration of the phenomena associated with oxidative phosphorylation at a new level of sophistication.

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Especially for Science and Mathematics Teachers

Ideas Questions Opinions

Weather Involvement for Elementary School Students

A four-week unit on weather in fifth grade general science classes has been successful because of personal involvement of the students in direct observation of the daily weather. Emphasis was placed upon a routine daily weather observation conducted entirely by the class. The large, inexpensive laboratory of the outdoors was used. The only "store-bought" instruments were an outdoor thermometer and an aneroid barometer; the rest of the measurements were made by careful individual observation and aided by student-constructed instruments.

The unit was begun by introducing the instruments of meteorology and pointing out the methods and value of careful observation. Recording, chart-keeping, and graphing were introduced for the observation program. Observations were made at 1000 EST so that they could be compared with airways and synoptic observations. The observations included records of atmospheric temperature and pressure, cloud cover and prevailing weather, wind direction, wind speed on the Beaufort scale, and, as observation became keener, cloud types.

The next phase of the unit was discussion of air masses and frontal weather with the typical cloud formations. It was then possible for the class to follow weather systems with the daily observations and the daily forecast and forecast map in the local paper. Simultaneously, individual student projects were chosen either to build a crude instrument according to the directions in the textbook (1) or to prepare a report on a particular weather phenomenon. As the students demonstrated their completed instruments, the resulting measurements were added to the observation schedule. Some of the instruments constructed were rain gauges, anemometers, wind vanes, water column barometers, and hair hygrometers.

The final phase consisted of reports and discussions of particular weather phenomena such as tornadoes, thunderstorms, or snowflake formation. The knowledge gained was reinforced with a review and test at the end of the unit. The unit was judged successful because test scores were higher than usual at all ability levels and a great deal of student enthusiasm went into the daily observations and projects. The major factor was the involvement of the students to the point where they were willing to dash into the rain to make observations or to interrupt the teacher by shouting that it was time for the 10 o'clock observation, no matter what was being taught at that time. The students also seemed

to benefit from the daily practice of careful observation and attention to detail in their later schoolwork.

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Reactor Facility
University of Virginia

QUESTION

Does anyone in the state have cultures of fruit flies which might be available for students interested in projects involving these organisms? Would these cultures be available free?

At times, professors of genetics at the various colleges and universities have fruit fly cultures which they might be willing to let you have free or for a nominal fee. You should check the institutions in your area prior to the date you will be needing the flies.

The Carnegie Institution Genetics Research Unit at Cold Spring Harbor, New York 11724, has an excellent pamphlet, *Drosophila Guide*, for 50 cents. This has experiments suitable for high school students.

QUESTION

Would a physics professor be available to come to Northern Virginia and talk about nuclear physics (latest advances in—quarks, etc.) to a group of science teachers? This would be an opportunity to help in a very substantial way to the omnipresent need science teachers face for updating.

Each year the Virginia Academy of Science prepares a list of "visiting scientists" who have volunteered to visit high schools and give lectures in their fields of interest. If you have not already received a copy of these speakers you should write to Dr. Rae Carpenter, Jr., Department of Physics, Virginia Military Institute, Lexington, Virginia 24450.

QUESTION

We have been growing planarians by the millions at our school and have tons of asexual re-

production, but never any sexual reproduction. Once we had a monster planarian which "laid" (3) a cocoon, but none "hatched." What would be the conditions necessary to induce reproduction? Territory?

I imagine you refer to either the small, somewhat spotted pond planarian, *Dugesia tigrina*, or to its larger, darker relative, *Dugesia dorotocephala*, which lives in springs or spring brooks. These two species occur in several varieties or races, sexual and asexual, and if your planarians reproduce solely by fission it is probably a matter of inheritance to a great extent. Hyman (1) found that sexuality could be induced in *D. tigrina* by a rising temperature following a sojourn at a cold temperature, but I have had no success with this procedure.

According to several reports the sexual race of *D. tigrina* develops reproductive organs and produces cocoons during the cold months of the year, then loses its sexual organs and reverts to reproduction by fission during warmer months. Kenk, in a study of Virginia triclad (2) found asexual *Euplanaria tigrina* (*Dugesia tigrina*) in several localities in Virginia, but saw traces of sexual *E. tigrina* only at the outlet of Westhampton Lake, near the University of Richmond, and at Trice's Lake in Cumberland County.

Euplanaria dorotocephala, (*Dugesia dorotocephala*) which can be distinguished by its larger size and pointed auricles, was found by Kenk only in the asexual state in Virginia. A few years ago I found a sexual race of this species at Farrier's Pond, a few miles from Mountain Lake (Giles County, Virginia), but, in the laboratory, these animals deposited cocoons only irregularly and the majority of the cocoons failed to hatch. Sexual races of *D. dorotocephala* have been reported principally from Oklahoma and from one or two places in Texas (3, 4). These Oklahoma sexual planarians differ from the *D. tigrina* sexual race in that the mature adults remain sexual and produce cocoons with living young during all months of the year.

My best suggestion for raising sexual planarians is to obtain specimens of a sexual race to begin with which, of course, is easier said than done. As stated above, collecting such appears to be somewhat of a problem in Virginia. I believe some biological houses supply sexual specimens during certain months of the year. As another possibility, I have sexual specimens all year, which are descendants of Oklahoma *D. dorotocephala*, and am occasionally overstocked. If a request should come in at a time I could spare some animals I would be willing to sell a few specimens of my sexual race, together with cocoons.

If you wish to attempt collections in various localities, the best place to look (for sexual *D. dorotocephala*) is near the headwaters of a constant temperature spring. Sexual specimens should be close to an inch in length, or longer. In them a white gonopore, a short distance posterior to the mouth should be clearly visible to the naked eye. The presence of sperm will be indicated by two white, wavy

lines on either side of the area between the mouth and the gonopore.

Many people have developed the habit of using the term, planaria, when referring to one specimen. Though the term is wide spread, it is still technically incorrect. The proper term is planarian, singular, and planarians, plural. The word *Planaria* is a genus name of a kind of planarian that is rarely found in the United States, and should not properly be used to refer to specimens of other common genera such as *Dugesia* or *Phagocata*.

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MARIE M. JENKINS

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(Editor's Note:

Dr. Jenkins has recently published a book, *Moon Jelly*, by Holiday House, which is an easy-to-read life cycle story of the jellyfish appropriate for lower elementary grades. A second book, *Animals Without Parents*, will be published in September 1970.)

BOOK REVIEW

Creative Biology Teaching

By DELMA HARDING, ROGER VOLKER
and DAVID FAGLE

Iowa State University Press
Ames, Iowa, 1969
342 pages, \$10.00

The authors state, "This text was written to help teachers solve the everyday problems they meet in the classroom and in the field, and to make them aware of the exciting challenges that exist in teaching modern biology."

The book may not be all that the authors claim for it, but it definitely tends to add support to the laboratory-oriented biology classroom often spiced with audio-visuals.

The presentation is not intended or designed to be an indepth sourcebook for biology teachers but it is an interesting combination of suggestions in teaching methods, classroom organization and innovations or teaching aids. Photographs of actual classroom activities relate the materials and ideas to the reader. The appendices which are sourcebook-like provide the details for utilizing the suggestions and methods. Two appendices, "Using Plant Materials"

and "Techniques Using Animals" present few if any unique classroom ideas but the twenty page presentation, "Working With Protists" is worthy of mentioning. *Tetrahymena pyriformis*, a small, primitive ciliate, is reported here as an interesting protozoan to observe, culture and use as a demonstration for conjugation when mating types have been isolated.

The chapter covering "Personalized Teaching" would be equally appropriate to the beginning or experienced teacher. This chapter and the above favorably-reported appendix are the strong points of the book.

In general this text would be of definite value in the personal-professional library of a junior high school teacher of natural science. High school biology instructors would find it useful only as a supplement to their normal collection of texts concerned with methods and materials or "How to Teach Biology" books.

GERALD C. LLEWELLYN

TEACHERS!!

Do you have a question that you'd like answered?

Do you have a favorite demonstration, method of getting across a concept, or an experiment that you'd like to share with others?

Do you have a technical article that you'd like to have published?

Are you involved in a program, a course of study, or an activity which you think would be of interest to other educators?

Would you like to analyze or give a critical evaluation of a curriculum, talk, article, or book?

Would you like to do a little philosophizing?

GREAT NEWS—NOW IS YOUR CHANCE!!

The editor of the Virginia Journal of Science plans to devote a page or two in each issue to items written especially for junior and senior high school teachers of science and mathematics. We are now soliciting contributions which will be of interest to teachers and which will be of value in furthering scientific and mathematical education in the state.

Send your contributions to Virginia C. Ellett, Mathematics and Science Center, 2200 Mountain Road, Glen Allen, Virginia 23060. Do this right away so that they may appear in the next issue of the Journal, but don't stop here. Let this be the beginning of many articles from you. Remember this is YOUR section and its success depends upon your contributions.

Communications and Reports

VIRGINIA ACADEMY OF SCIENCE

Summary of Council Meeting*
March 15, 1970

President Carpenter presided at the March 15 meeting of Council which was convened in the Larkick Student Center of MCV. He reviewed briefly the meeting of the Executive Committee held February 8 in Richmond and announced that W. P. Boyer had resigned as Trustee and that a new appointment would be made in the near future. He also announced that the Ad Hoc committees on Executive Officer and on Restructuring of Life Sciences had completed their assignments and had been discharged. He announced that the Executive Committee had selected the title of Associate Executive Secretary-Treasurer for Mr. Bruner and that the incidental expenses of the Executive Secretary-Treasurer's office would be reimbursed on a fixed fee basis.

Auditing and Mailing Services

Mr. Berry reported that alternate mailing service is being considered but that present prospects indicated that our present supplier will be less expensive. Mr. Bruner reported that our present auditor, Waddell Rison and Associates, would be unwilling to undertake a materially simplified audit and felt that essentially all of their present procedures were necessary for a certified audit and tax report. Council then approved a motion by Dr. Harshbarger that Rison and Associates be retained as auditors.

Virginia Museum of Science

Dr. Austin Grigg reported that the Museum of Science had been approved by the state legislature and the requested initiating funds had been appropriated. A balance of \$2,137.29 in committee funds remains on hand. Mrs. Remsburg expressed the desire that a Museum Trustee be named from Northern Virginia and will submit a name for consideration. Mr. Midyette moved that the Academy's Museum of Science Committee be requested to select nominees for Museum of Science trustees to be submitted to the Governor. Motion was approved.

Membership

Dr. Carpenter briefly discussed the fund raising problems of the Academy and Dr. Harshbarger commented on the prospects of upgrading membership dues. It was suggested that the chairman of the membership committee be requested to consider means of upgrading the dues structure and President Carpenter agreed that this would be done.

* Abbreviated by the Editor from minutes provided by Blanton M. Bruner, Acting Secretary.

Local Arrangements

Mr. Maurice Rowe complimented Drs. Burke and Campbell for their outstanding work on arrangements and stated that all plans for the May meeting were well on schedule.

Governor's Science Advisor

Mr. Rowe suggested that Dr. Siegel continue as the Governor's Science Advisor and moved accordingly. The motion was approved and Dr. Carpenter requested Dr. Siegel to report on his activities. Dr. Siegel stated that contacts have been made on a regional, state, and national basis and will be continued.

Trustees

Mr. Bruner, reporting for Mr. Harlow, stated that at the present time the trustees did not recommend any change in the investments of the Foley Smith, Horsley, or Research funds, however they would keep the Executive Committee request for an investment review of these funds under consideration.

Virginia Journal of Science

Dr. Abbott in reporting for the Virginia Journal of Science discussed at some length present handling of abstracts of papers presented at the annual meeting. Several suggestions were discussed; however, this matter was not resolved.

Awards Committee

Dr. Abbott submitted a written report for the committee, which nominated eight names for election as "Fellows of the Virginia Academy of Science." Dr. Abbott then moved that the names be accepted as a group. Motion was approved. Dr. Williams moved that the awards committee determine the wording for the award certificates. Motion was approved. Presentation of certificates will be made at annual meeting in May.

Other Committees

No reports were received from the following committees:

Long Range Planning
Finance and Endowment
Virginia Flora
Talent Search
Publications
Virginia Junior Academy of Science

Executive Secretary-Treasurer

Dr. Carpenter then asked Mr. Berry if he would leave the meeting temporarily and after the departure of Mr. Berry, suggested that a special award be made to Mr. Berry at the annual meeting. He

proposed an honorary life membership for Mr. Berry with an appropriate certificate and wallet membership card and a silver tray bearing both Mr. and Mrs. Berry's names in appreciation for their services to the Academy. Dr. Harshbarger moved that this procedure be followed. Motion was approved.

Section Numbering

President Carpenter then discussed the VAS Section numbering and the present numerical code, and distributed copies of a prepared sheet concerning this subject. After some discussion, Wightman moved that as of the time Botany becomes a Section of the Academy, Section 6x (Space Science and Technology) and Botany be designated as Sections 13 and 14. Motion was approved.

Future Meetings

Dr. Carpenter announced that the arrangements committee for the 1972 meeting is in the process of formation.

He also announced that future annual meetings had been scheduled as follows:

- 1971—Virginia Polytechnic Institute
- 1972—Virginia Military Institute and Washington and Lee University
- 1973—Williamsburg, Va.—joint invitation from the College of William and Mary and Colonial Williamsburg

Dr. Williams read the letter of joint invitation dated December, 1965 to Dr. Hughes who was then President of the Academy reporting that the invitation had been accepted by council in March of 1966. After some discussion of anticipated room rates Dr. Harshbarger moved that plans for 1973 meeting be continued. Motion passed.

Dr. Carpenter reported that Old Dominion College, Norfolk, had invited the Academy for 1974. He stated that the Executive Committee had contacted the Golden Triangle regarding accommodations and does not feel that a definite decision should be made at the present time. Mr. Midyette moved that the invitation be tabled and that the Executive Committee investigate further and report at the May meeting. Motion passed.

Dr. Harshbarger suggested that other areas of the state be considered—such as Harrisonburg and Northern Virginia—for the annual meeting and Mr. Rowe suggested that President Carpenter appoint one or more individuals in other areas to investigate

the feasibility of holding the annual meeting in these respective areas.

Revision of Constitution

After an adjournment for lunch Council reconvened and the balance of the afternoon was devoted to a review—article by article—of the proposed revision of the Constitution of the Virginia Academy of Science. The revision committee was instructed to rewrite the proposed revision in accord with the changes approved.

The meeting was adjourned at approximately 5 P.M.

Computer Languages: A Practical Guide to the Chief Programming Languages

By PETER C. SANDERSON

Philosophical Library, Inc.
New York, 1970
200 pages, \$15.00

This attractive, expensive little book is, we read from the fly-leaf, "designed to introduce in one volume all the chief high-level machine-independent programming languages. The languages have been presented in such a way that the reader will not require a high standard of mathematics."

The eight chapter headings are:

- (1) Introduction to digital computers
- (2) Introduction to computer programming
- (3) Computer languages
- (4) Algol 60
- (5) Fortran
- (6) Cobol
- (7) PI/I
- (8) Extended mercury autocode

Suggested solutions to problems are also given, and the remote-console oriented language "Basic" is discussed in an appendix.

The first three chapters require only 25 pages, will not be of much use to the novice and will be trivial to the expert. The information contained in the remaining chapters can be found in the reference manuals provided by the various computer manufacturers.

Perhaps the author, who teaches computer science in London, considers the mercury autocode to be a chief programming language in England, but certainly it is not important in the United States.

JOHN R. HOWELL

News and Notes

MOUNTAIN LAKE SUMMER PROGRAM

High in the Virginia mountains, at a lake surrounded by "murmuring pines and hemlocks," is a classroom for students enrolled in a summer program at the University of Virginia. The setting is the University's Mountain Lake Biological Station. Located in Giles County 4,000 feet above sea level on the divide between the Mississippi and Atlantic drainage areas, the station was founded in 1930 to provide the only inland facility in the Southeast for research and advanced training in field biology.

Each summer students from throughout the United States and several foreign countries, most of them working towards advanced degrees in biology, enroll in one or both of the two terms. Because the courses are so intensive, encompassing lectures, work in the well-equipped laboratories and field study, students take only one course each term. This June, some 100 students, many with spouses and children, took up residence in the stone dormitories and cottages and started work.

Dr. Fred Diehl, assistant professor of biology at the University of Virginia, who teaches invertebrate physiology, pointed out that the courses are really all-day affairs. Students live and work together in the same area and the result is a real learning community. Except when sleeping, they're involved in the course. Although many informal parties are organized at night, there isn't much at the station to distract the student from his studies.

Course emphasis is on ecology, environmental biology, evolution and the study of animal groups, and the faculty is chosen from universities throughout the United States. This summer courses ranged in subject from animal behavior to pteridology, the study of ferns—there are 90 species of ferns at Mountain Lake.

In discussing the founding of Mountain Lake Biological Station, the late Dr. Ivey F. Lewis, a former director of the station and first president of the Virginia Academy of Science, once said, "Our thought was to have a laboratory or teaching station right in the woods, close to nature, where people would not be so dependent on bottles, pickled and dried stuff, but see things as they actually are, in the open."

The late John B. Laing of Pembroke, Virginia and Mr. and Mrs. James W. Wiltshire of Lynchburg have made available more than 1,200 acres of woodland for the Station's use. The Station is adjacent to the Jefferson National Forest where more than 100,000 acres are available for study. Another 1,500 acres in the area also is kept entirely in a natural state. Almost all the major habitats of flora and fauna—lake, mountain, forest, stream and valley, are within easy reach of the Station. But the most interesting feature is the lake itself. Natural lakes are infrequent in the South since the glaciers which scraped out lake basins didn't come down this far,

and what natural lakes there are are not usually high in the mountains. No one knows how the lake was formed but its existence has been known since the mid-18th century. In 1809 a Virginia nurseryman named John Lyon visited the lake, then known as Salt Pond, and described it in his journal: "The Pond or Lake is about a mile and a quarter long, by half a mile broad to which there is a little descent from the highest summit of the mountain. Why it has obtained the name of the Salt Pond I cannot learn, but the water is certainly quite fresh and clear." Today, 160 years later, the water is still fresh and clear. Pollution has made few inroads in the area, and the past 30 years have seen the regeneration of forest land that once had been logged heavily.

Students can observe an animal population which includes wild turkeys, deer, bears, wildcat, spotted skunks, red squirrels and numerous birds. The plants are typical flora of mountain deciduous and coniferous forests and include rare lilies and orchids. Flora in nearby bogs include a small carnivorous plant called the sundew and sphagnum moss.

Dr. J. James Murray, Jr., associate professor of biology and co-director of the Station with Dr. James L. Riopel, associate professor of biology, emphasized, "We try to avoid over-collecting, and we leave the habitats as close to the way we found them as possible. We also spread our activities so the impact isn't concentrated in one area."

BAILEY-LAW COLLECTION—ROCKBRIDGE ALUM SPRINGS BIOLOGICAL LABORATORY

An unusual gift to Virginia Polytechnic Institute from the Bailey Research Trust has resulted in one of the university's outstanding research collections, the Bailey-Law Collection of natural science. The collection, composed of between 8,000 and 10,000 specimens of bird skins, about 4,000 mammal skins and skulls, and many mounted birds, is located at Rockbridge Alum Springs near Goshen in Rockbridge County.

Dr. John P. Hubbard was named curator of the collection in 1969, and is currently conducting research at Rockbridge Alum Springs, as well as working to complete the cataloguing of the thousands of specimens, which he describes as a major teaching and research collection. The collection is housed in a natural science museum—the dream and ambition of the late Harold H. Bailey. The location, Rockbridge Alum Springs Biological Laboratory, is a former hot springs spa which flourished around the turn of the century, when such forms of relaxation were popular. It is now leased by the University and is available to Virginia Tech faculty and students for studies.

Mr. Bailey purchased the old spa after it had outlived its usefulness as a resort. He died in 1962. Mr. Bailey was a naval architect and did most of the work on the place himself, beginning in 1942.

It was during the war years and help, as well as material, were impossible to get. The old hotel and cottages were in complete disrepair and some were impossible to save. Mr. and Mrs. Bailey, working together, turned the old buildings into a home for themselves, preserved many of the old cottages and furniture, and converted the old ice house into a green house.

Mrs. Laura Bailey still lives and works constantly on the place, adding to the many flower gardens and sprucing up many of the existing buildings. As a naturalist, Mr. Bailey worked for many years to collect and purchase the birds, eggs, nests and mammals that are now part of the Bailey-Law natural science collections. Also an author, he wrote "The Birds of Virginia" and the "Birds of Florida."

Dr. Hubbard rates the collection outstanding. Some of the specimens are of extinct creatures, and it is impossible to even purchase them any more. There are specimens of the condor of California, which although not extinct, are protected by law. There are Carolina Parakeets and Ivory-billed Woodpeckers, both extinct. Many specimens are in series—from oldest to youngest—which is an invaluable aid to researchers using the material. Part of the collection, Dr. Hubbard notes, came from J. Eugene Law, also a naturalist, who was Mrs. Bailey's first husband. The collection is primarily of specimens from North America, with nearly all of the 530 species of birds and 275 species of smaller terrestrial mammals represented. Mr. Law contributed many of the specimens from Southwestern North America. The collection also includes a complete library of ornithology, with three complete bird journals and a complete set of the Journal of Mammalogy and many books on mammals and other animal groups.

Dr. Hubbard, a graduate of Western New Mexico University, received his master's and doctor's degrees at the University of Michigan. He has worked extensively with the collections of the University of Michigan and the U. S. National Museum of the Smithsonian Institution. His main research interests are in bird taxonomy, distribution and biology. He, his wife and three-year-old son live at Rockbridge Alum Springs.

NSF SUMMER PROGRAM FOR HIGH SCHOOL STUDENTS

Thirty-two high school students spent a major part of their summer vacation at the University of Virginia learning more about the fields of electrical science and electronics engineering. The students, juniors and seniors in high schools from 15 states, were enrolled in an eight-week National Science Foundation secondary training program in electrical science and electronics engineering which ended August 8. For the first six weeks, the students divided their time between the lecture room and the laboratory where members of the School of Engineering and Applied Science's electrical engineering department introduced them to the basic theory and practical aspects of electronics engineering as well as the laboratory approach to problem-solving. The

remainder of the program was spent at the United States Army Electronics Command at Ft. Monmouth, N. J. There each student worked with a scientist or engineer on a specific problem related to the students' capabilities and interests. While at the University of Virginia the students also had opportunities to learn about computer use and to visit ongoing research projects in the engineering school.

Dr. E. C. Stevenson, professor of electrical engineering, was program director. Among the 32 students were seven from Virginia: Lewis L. Campbell, Raven; Michael V. Campbell, Fredericksburg; John P. Croce, Falls Church; James E. Gettys, Manassas; Carl M. Mitchell, Hurley; Robert S. Mullins, Clintwood; and David A. Roos, South Boston.

MEDICAL EXPLORER SCOUTS

The Medical College of Virginia hosted 150 junior and senior high school students from seven states at a special Medical Explorer Seminar the third weekend in June. The seminar for teenage boys and girls in medical exploring posts in Region III of the Boy Scouts of America was the first seminar in the Middle-Atlantic states and the third such seminar in the nation.

Participants in the seminar at MCV, the Health Sciences Division of Virginia Commonwealth University, came from Pennsylvania, Maryland, Delaware, West Virginia, Virginia, Washington D. C., and several from New York and Missouri. The Robert E. Lee Council, Boy Scouts of America, Richmond, was co-host for the seminar.

The special interests program included discussions by MCV faculty on medicine, pharmacy, physical therapy, and nursing. Dr. William E. Laupus, professor and chairman of pediatrics at MCV, gave the keynote address on "Medicine in a Changing World." The students attended seminars throughout the Health Sciences Center on medicine, neurology, obstetrics and gynecology, pediatrics, pathology, psychiatry, and surgery. Dr. A. Epes Harris, Jr. of Blackstone conducted a session on general practice.

Craig R. Rudlin, Richmond Eagle Scout who has designed and patented a heart-lung machine, spoke at the Saturday night dinner in the Lerrick Student Center. A special church service in historic Monumental Church on the MCV campus concluded the seminar.

Dr. William P. Spencer, associate professor of pediatrics at MCV was coordinator for the weekend activities. Executives of the Boy Scouts of America, John Claerhaut, assistant chief scout of the Boy Scouts of America; Olaf Slostad, Region III scout executive; E. M. McAllister, deputy regional scout executive for exploring; and Ralph W. McCreary, member of the National Exploring Committee also attended.

HCN REDISCOVERED

Astronomers at the University of Virginia and the National Radio Astronomy Observatory have discovered another complex molecule in outer space.

The latest discovery—of hydrogen cyanide (HCN)—was made during the first week of June,

using the 36-foot radio telescope of the National Radio Astronomy Observatory at Kitt Peak, Arizona. The discovery was made by Dr. David Buhl of the National Radio Astronomy Observatory and Dr. Lewis E. Snyder, assistant professor of astronomy and a member of the Center for Advanced Studies at the University of Virginia.

Radio signals from the molecule were detected in clouds of gas and dust located trillions of miles in deep space, far beyond the earth's solar system. HCN is the second complex molecule containing more than two atoms detected in interstellar gas clouds. Formaldehyde, the first such interstellar molecule found, was reported in March, 1969, by Dr. Snyder, Dr. Buhl, Dr. Benjamin Zuckerman of the University of Maryland and Dr. Patrick Palmer of the University of Chicago. Formaldehyde has since been found to be a major constituent of many distant interstellar clouds in the earth's galaxy. Other molecules reported by radio astronomers include ammonia, water, carbon monoxide and the cyanogen and hydroxyl free radicals. These are being studied in an emerging new branch of astronomy called "astrochemistry" or more correctly "astromolecular radio spectroscopy," according to Dr. Snyder.

The newly detected hydrogen cyanide emission signal will be used to probe the secrets of deep space. Its chemical properties are already well known to terrestrial scientists.

Many space scientists are already speculating about the chemical implications of interstellar clouds of complex molecules and how they might fit into an evolutionary pattern of life throughout our galaxy. It is known that HCN can play a role in the formation of amino acids in laboratory reactions.

Dr. Snyder and Dr. Buhl reported the discovery to the American Astronomical Society. The National Radio Astronomy Observatory headquarters are located in Charlottesville and it operates telescopes at Green Bank, West Virginia and Kitt Peak, Arizona.

MEDICAL DEAN HONORED

Dr. Kinloch Nelson, dean of the School of Medicine at the Medical College of Virginia has been elected a Master of the American College of Physicians. The honor was conferred in April, at the convocation of the annual session of the American College of Physicians in Philadelphia.

Dr. Nelson has been dean of the School of Medicine at MCV, the Health Sciences Division of Virginia Commonwealth University, since 1963 and a member of the MCV medical faculty since 1929. He was graduated from the University of Virginia School of Medicine in 1927.

A native of Richmond, Dr. Nelson is a former president of the Richmond Academy of Medicine and a former speaker for the house of delegates of the Medical Society of Virginia. He was governor for the state of Virginia for the American College of Physicians from 1959 until 1965, and has been a

member of the Virginia Academy of Science for many years.

UVA HONORS

Dr. James W. Ogilvie, associate professor of biochemistry, received the 46th annual President and Visitors' Research Prize, and Joseph P. Chinnici of Philadelphia, candidate for the Ph.D. degree in biology in June, received the Andrew Fleming Prize for research at the University of Virginia. The President and Visitors' Research Prize recognizes outstanding research in pure and applied science, while the Fleming award goes each year to the outstanding graduate student in biology.

Dr. Ogilvie was honored for his work heading a research team which, after studying how an enzyme controls a critical reaction in living organisms, proposed a mechanism to explain how the enzyme becomes active on demand and shuts off when the demand diminishes. Their research paper, entitled "Homoserine Dehydrogenase of *E. coli* K-12-lambda: Feedback Inhibition by L-Threonine and Activation by Potassium Ions," has drawn praise from experts around the country. Assisting in the research were Dr. James H. Sightler, a resident in pediatrics at the Johns Hopkins University, and Richard B. Clark, a University graduate student from North Garden, Virginia.

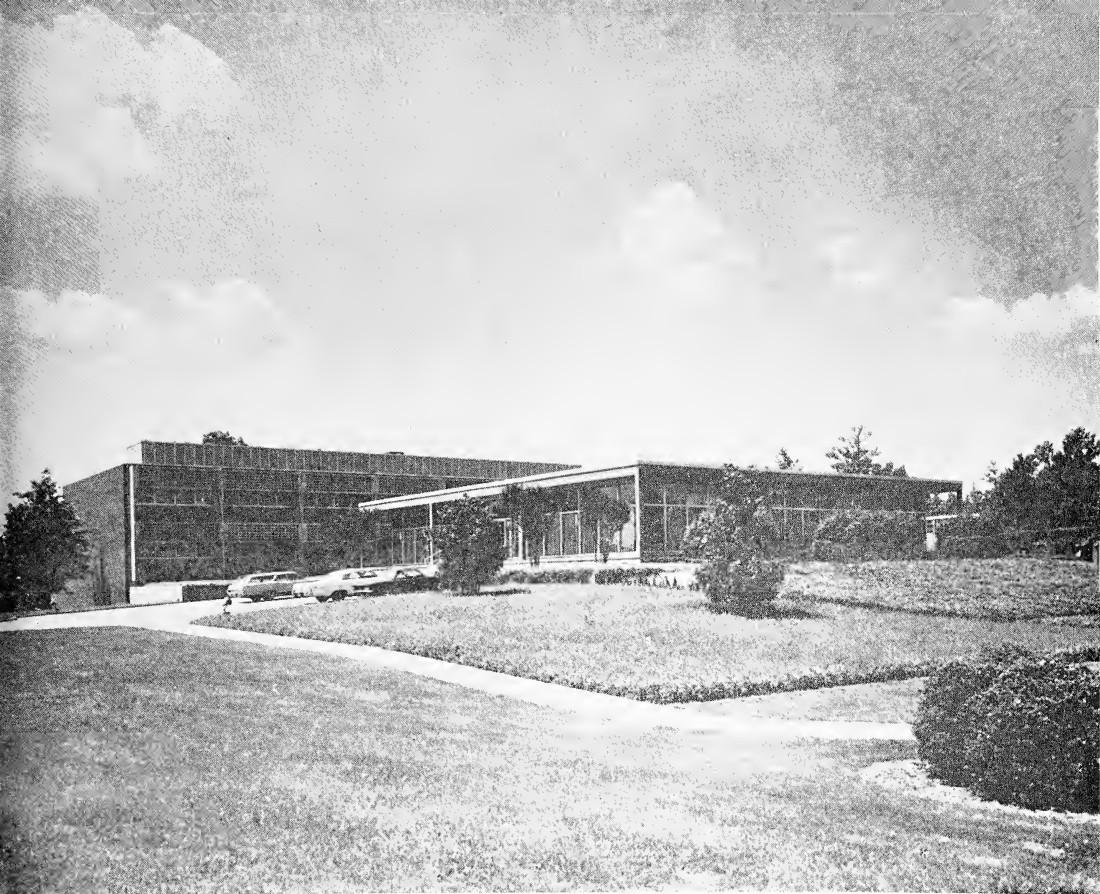
Dr. Chinnici's major research interest is the experimental modification of genetic linkage. Using the *Drosophila* or common fruit fly, he experimented with modifying by selection the frequency with which crossing over of genes from chromosome to chromosome takes place.

Honorable mention for the President and Visitors' Prize went to Dr. Alan M. Lefer, associate professor of physiology, and Julian Martin, research assistant, for their paper on "Relationship of Plasma Peptides to the Myocardial Depressant Factor in Hemorrhagic Shock in Cats."

CARDIOVASCULAR LABORATORY DEDICATED

The Medical College of Virginia officially dedicated its new cardiovascular laboratory to the late Mr. Leo Rosenthal on May 20, 1970. The laboratory for heart catheterization was made possible largely through a gift from Mr. Rosenthal to MCV, the Health Sciences Division of Virginia Commonwealth University. Mr. Rosenthal, who died in June 1969, was a 1917 graduate of the MCV School of Pharmacy.

The laboratory and its equipment for heart catheterization gives MCV physicians a facility for precise heart diagnosis. Direct measurements are made of heart function by taking pictures of the heart by injecting a solution opaque to X-rays through catheters into the heart chambers or blood vessels. The image is recorded either on motion picture film, at a rate up to 80 pictures per second, or on large X-ray film, at rates up to six pictures per second.



PHILIP MORRIS



Philip Morris, a publicly-owned company incorporated in Virginia, proudly traces its heritage to a London tobacconist of a century ago. Quality and innovation have earned for the company a valued reputation: "Philip Morris . . . makers of America's finest cigarettes." In addition, the Company markets a number of fine pipe tobaccos, and in recent years Philip Morris has added these quality names: Burma-Vita Company, American Safety Razor Company, and Clark Bros. Chewing Gum Company.

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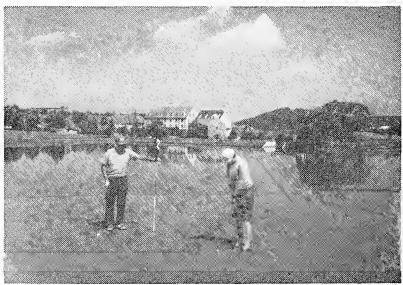
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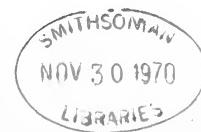
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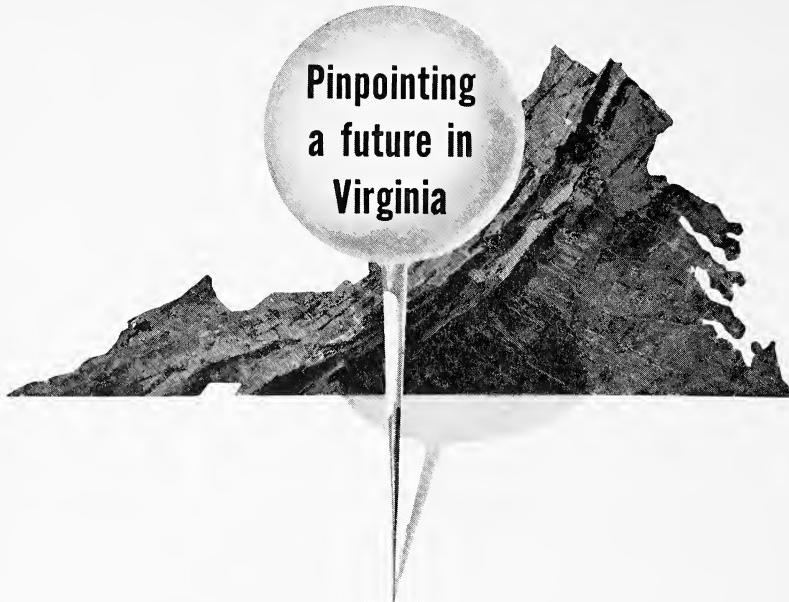
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VIRGINIA JOURNAL OF SCIENCE

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SUMMER
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The front cover is by Douglas C. Hensley.

**Elmer W. Ramsey, Kenneth R. Hinkle and
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Received June 23, 1970*

Waters of the Dismal Swamp*

Introduction

Dismal Swamp occupies an area of approximately 600 square miles on the Atlantic Coastal Plain in Virginia and North Carolina (Fig. 1). In Virginia the Swamp covers all of eastern Nansemond County southeast of Suffolk and a large portion of western Chesapeake. The Coastal Plain is a gently sloping lowland characterized by a series of flats and scarps that rise in steps westward from the sea. The scarps represent former elevations of the sea above the present level which occurred during the Pleistocene Epoch of geologic time.

The most distinctive morphologic feature of the area is the Suffolk Scarp which forms a natural boundary along the western edge of Dismal Swamp. Elevation at the crest of the Scarp is 50 to 70 feet above sea level and the toe of the Scarp is 30 to 40 feet lower. The surface of the Dismal Swamp slopes gently eastward from the toe of the Suffolk Scarp to an elevation 15 feet above mean sea level at its eastern edge.

The Coastal Plain is underlain by a series of unconsolidated sands, clays, and gravels which range in geologic age from Cretaceous to Recent. These sediments dip gently southeastward and usually do not occur continuously over wide areas due to different depositional environments and removal by erosion. A deposit of peat up to 11.5 feet thick in some places covers the older sediments throughout the Dismal Swamp.

No known previous studies have been made of the water resources in Dismal Swamp. The Virginia Division of Water Resources has recently published a report on ground water in Southeastern Virginia (1), and an earlier report by D. J. Cederstrom (2) also describes the ground water resources of Southeastern Virginia. However, neither of these reports make any specific reference to ground water in Dismal Swamp. A comprehensive study of the post-Miocene stratigraphy and morphology in this part of the Coastal Plain was completed by Robert O. Oakes, Jr. in 1964 (3).

Ground Water

As pointed out in the preceding paragraphs, specific data on ground water conditions in Dismal Swamp are not available at the present time. A few general observations can be made from data applicable elsewhere in the Coastal Plain and from the previous studies made in Southeastern Virginia.

It is known that the deep aquifers of Cretaceous age underlying this area are capable of producing several hundred gallons of water per minute; however, no wells are known to penetrate these units under Dismal Swamp. Water from the deep aquifers east of Suffolk is often of poor quality due to high chloride content (250 mg/l and above).

The Yorktown Formation of late Miocene age is relatively unimportant as an aquifer under most of Dismal Swamp due to the predominance of a clay facies. The clay serves as an aquiclude preventing downward movement of water from the overlying Pleistocene formations. Where the Yorktown Formation is characterized by shell and sand facies it may store small to moderate supplies of water. A well that penetrated a layer of shells apparently belonging to the Yorktown Formation at Bayville Farms just east of Dismal Swamp was tested at a rate of 98 gallons per minute. Most of the water-bearing zones in the Yorktown Formation occur between depths of 60 to 125 feet in this part of the Coastal Plain. Water from the Yorktown Formation is usually moderately hard to hard.

Pleistocene and Recent sediments are exposed at, or lie very near to, the surface throughout the Dismal Swamp area. The sandy zones in these deposits have been tapped by numerous shallow wells dug or driven for domestic use throughout the Coastal Plain Province. Well data are virtually non-existent for the shallow aquifers in Dismal Swamp, but it is probable that appreciable quantities of water would be available where the sands are sufficiently thick.

A layer of clean sand assigned by Oakes (3) to the Sand Bridge Formation of the Pleistocene series can be traced over much of Dismal Swamp. This sand stratum would seem to be one of the best sources of ground water in the area. It is up to

* Editor's Note: This is the fourth of a series of articles on the Dismal Swamp appearing in *The Virginia Journal of Science*. References to previous articles may be found in the Spring 1970 (no. 2) issue (*Va. J. Sci.*, 21, 41 (1970)).

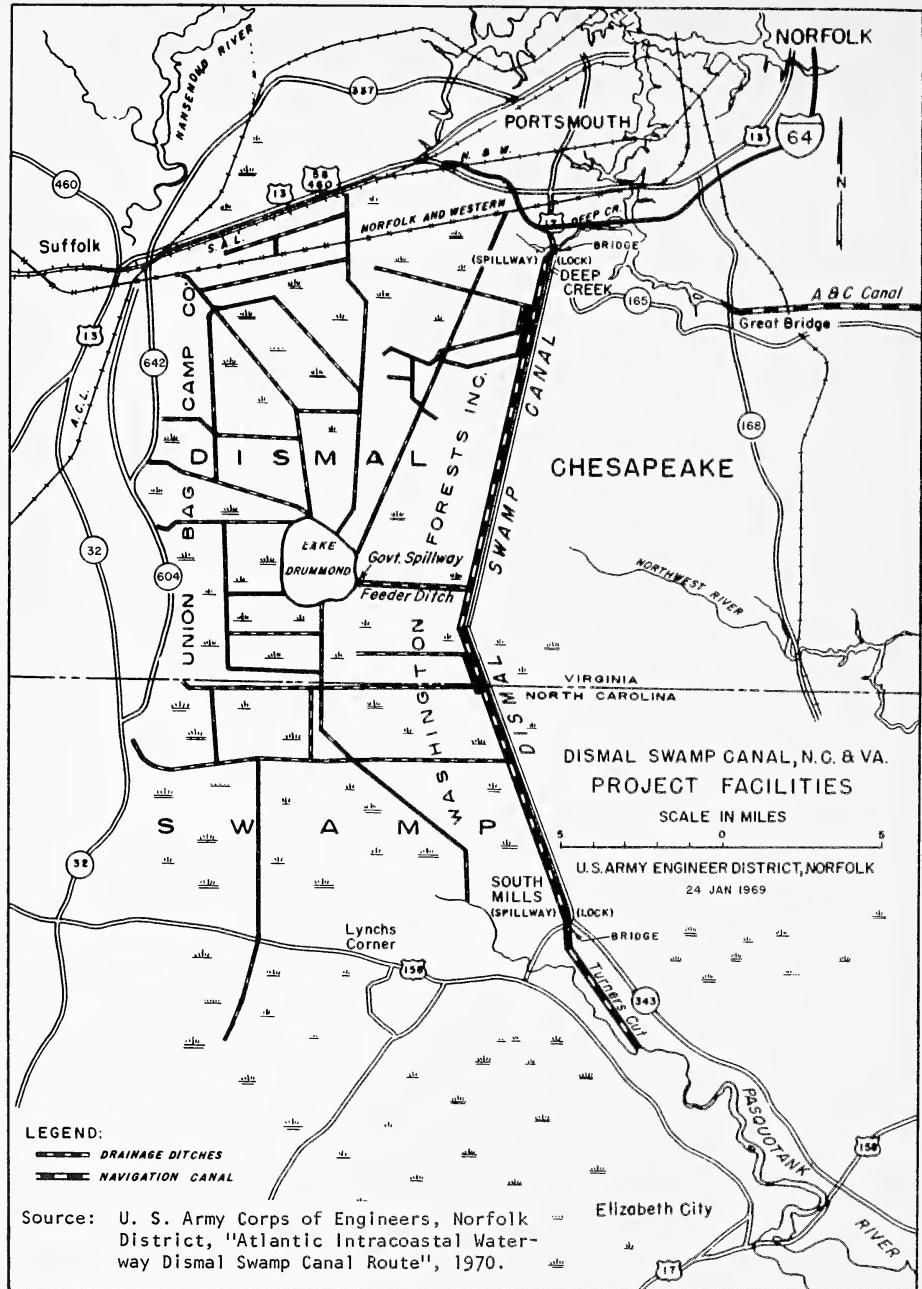


FIG. 1—Dismal Swamp Canal and Drainage Ditches.

eight feet thick in some places and is intercalated between two clay silt facies. Thus geohydrologic conditions are favorable for ground water accumulation, but the thinness of the aquifer would limit its storage capacity. A few other thin layers of sand occurring within the Pleistocene and Recent deposits may also store small supplies of ground water.

It is conceivable that some of the shallow aquifers underlying Dismal Swamp may receive recharge from sandy zones occurring along the Suffolk Scarp. Where slope and surface exposure of these zones are favorable along the Scarp, there may be rapid eastward movement of ground water from the catchment area west of Dismal Swamp.

The quality of the water from the shallow aquifers in this part of the Coastal Plain is often undesirable due to acidity, hardness, and excessive iron content, and in marshy areas hydrogen sulfide may be present.

Surface Water

Most of the central portion of Dismal Swamp drains into Lake Drummond by man made ditches and natural drainage patterns. The northern edge of the Swamp drains into tributaries of the James River. The southern portion of the Swamp drains into Northwest and Pasquotank Rivers. Water flows from Lake Drummond via the Feeder Ditch to the Dismal Swamp Canal. The flow in the Feeder Ditch is regulated by the Army Corps of Engineers. On March 30, 1929 the water usage rights at Lake Drummond and the Feeder Ditch between Lake Durmmond and the Dismal Swamp Canal were purchased by the United States.

Lake Drummond is a circular body of water, approximately 2.5 miles in diameter with a drain-

age area of about 140 square miles and depths up to six feet. The normal level of Lake Drummond is 17 feet above mean sea level with the highest level recorded since May, 1926 being 18.8 feet above mean sea level and the lowest level recorded being 11.5 feet above mean sea level.

Normal annual precipitation is about 48 inches per year. Surface runoff is 1.0-1.2 cubic feet per second per square mile.

Conclusions

To understand the hydrology of the Dismal Swamp area there is a need to develop a hydrologic budget. The study could involve detailed monitoring of precipitation, temperature, evaporation, surface runoff, and ground water levels. A number of test wells may be necessary.

The limited quantity of water available in Dismal Swamp raises the question as to the feasibility of developing these waters for any other outside use. Also, the question must be asked if these water resources have a development potential of significant importance to substantiate further study at this time.

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Extra-Experimental Interference from Letter-Sequence Habits

Abstract—Two groups of 30 Ss were allowed to individually pace their learning of six pairs of stimulus bigrams and single-letter associates. From the 1960 single-letter association norms of Underwood & Schulz, lists of high (.20) and low (.01) associative probability were derived. Because of stronger interference from letter-sequence habits, the low associative list required a significantly longer period of time to learn than the high associative list.

Introduction

Underwood and Postman (1) formulated the letter-sequence and unit-sequence hypotheses as corollaries to the interference theory of forgetting. Both hypotheses suggest that extra-experimental language habits are the likely cause of interference during learning and retention where extra-experimental habits reflect previous associations formed by an individual's normal use of language. More specifically, letter-sequence habits refer to associations formed between single letters, while unit-sequence habits refer to associations formed between units of two letters or more.

To test these hypotheses, Underwood and Postman (1) investigated the retention of three-letter combinations which formed either high or low frequency words, and high or low frequency trigrams. One group was tested for retention 30 sec after learning, while the other group was tested for retention one week later. Their results indicated that interference was greater for low frequency units, which supported their prediction of an inverse relationship between frequency of occurrence and amount of letter-sequence interference. However, according to Underwood & Postman (1): "The present study has given some evidence that extra-experimental sources of interference can be treated analytically. The critical requirement is to know what associations the subject brings to the laboratory and then present him with a task where these associations will have to be broken, inhibited, or extinguished. The lists used in the present study were believed to meet this requirement, although, as pointed out earlier, it would be quite possible to show this more clearly than we have" (p. 94).

Underwood and Schulz (2) calculated the asso-

ciative probabilities between single-letter stimuli and single-letter responses from data obtained from 273 college students. Associative probability means the probability that a certain response will be elicited by a certain stimulus in a free association test. Underwood and Keppel (3) used these letter-letter associative probabilities to test the letter-sequence hypothesis in an experiment where two lists were formed by pairing single letters according to high (.03) or low (.00) associative probability. The lists were then presented in paired-associate form, and the Ss were tested for retention after one day and 7 days. The speed of relearning did not support the letter-sequence hypothesis; however, their failure may be attributed to the very small difference between the mean associative probabilities of the two lists (only 3%). Concerning the small difference between their lists, Underwood and Keppel (3) stated: "The HA (high associative) list was not 'high' in an absolute sense . . . Nevertheless, support for the hypothesis might be obtained if wider differences in initial associative strength were used . . ." (p. 14).

Blick and Anderson (4) reported the results of an experiment that tested the letter-sequence hypothesis using lists of paired single-letter stimuli and responses. Their high associative (HA) list had a mean probability of .14, while the low associative (LA) list had a mean probability of .00. Their Ss were allowed to individually pace their learning of the lists, and the Ss who learned the HA list required a significantly shorter time to learn the list, and also had a higher percentage of correct responses during immediate recall. Blick & Anderson's conclusion in support of the letter-sequence hypothesis is weakened somewhat by the fact that their two lists contained different response terms, and it is possible that differential frequency of occurrence of the response terms was a confounding variable.

The present experiment was designed to test the letter-sequence hypothesis using Blick and Anderson's (4) basic design as a model, but with the following significant changes: (1) an increase in the difference between the mean associative probabili-

ties of the two lists, from .14 to .19, (2) direct control over frequency of occurrence of the response letters of the two lists, and (3) bigrams rather than single letters were used as stimuli. It was predicted that the HA list would require a shorter period of time to learn than the LA list.

Method

Sixty-three male and female undergraduates at the University of Richmond were unsystematically divided into two groups. Three Ss were disqualified because of failure to follow the directions, leaving 30 Ss per group.

The apparatus was a three-page booklet consisting of a page of directions, a training page, and a test page. The first page contained a general set of instructions for an experiment in paired-associate learning. The training page presented six pairs of stimulus bigrams and response letters, and the test page presented the stimulus bigrams followed by a blank space for the S's answer. Both the training and test pages were headed by brief directions.

The Ss were trained and tested for immediate recall of the response terms in a paired-associate learning task. The task itself consisted of six stimulus bigrams paired with a single-letter associates. From the norms of Underwood and Schulz (2), lists of high (.20) and low (.01) response associative probability were derived. Both lists are shown in Table I along with the associative probabilities for

TABLE I
Underwood and Schulz Associative Probabilities for the HA and LA Lists

HA List		LA List	
S	R	S	R
DG-O	.30	DG-T	.02
QJ-R	.19	QJ-O	.02
KA-T	.34	KA-C	.01
SB-X	.21	SB-F	.01
PH-F	.08	PH-X	.01
UL-C	.11	UL-R	.02

Mean Prob. = .20

Mean Time = 54.9 sec.

Mean Prob. = .01

Mean Time = 86.6 sec.

each pair and the mean probability of each list. Note that the stimulus bigrams and the response letters are identical for both lists; therefore, the only difference between the two lists is the difference in associative strength between the bigrams and their single-letter responses. In addition, within each list there are no 3-letter word formations, no repetitions of letters, no adjacent alphabetical sequences, and a maximum of only one vowel per pair was allowed. Each list was arranged in three random sequences of presentation and three random recall sequences. The sequence of bigrams on the test page varied from the sequence of bigrams on the training page to preclude learning by serial order.

After receiving the test booklet, the E explained

that "the task is to learn to associate the response letter with the stimulus bigram. We are trying to find out how much time you need to learn the series of pairs. You will have as much time as you need to study the pairs, but since the emphasis is on speed, we urge you to master the pairs as quickly as possible." The Ss paced themselves in learning the list, and the E recorded the time to the nearest second. The instructions on the training page stated: "Study the pairs shown below. When you think you have mastered the list, turn to the next page and follow the directions at the top." On the test page, the S was allowed 60 sec to recall the response letters. The instructions read: "Now beside the appropriate stimulus bigram write in as many of the response letters as you can remember. If you cannot remember, write in the first letter that the stimulus bigram makes you think of. To do this, say the bigram to yourself and then fill in the blank with the letter that comes quickly and naturally."

Results and Discussion

When both lists were compared for the percentage of correct recall responses, 95.6% for the HA list and 97.2% for the LA list, the difference was not significant. A test of the difference between the two percentages produced $z = .84$, $p > .05$. However, it required different amounts of time for both groups to reach similar levels of recall. The Ss exposed to the HA list took an average of 54.9 sec, while the Ss given the LA list required an average of 86.6 sec. The difference of 31.7 sec in the learning times is significant, $F(1,58) = 13.08$, $p < .05$.

The present experiment fits in rather well with the rationale of research in the area of extra-experimental sources of interference. For instance, Underwood and Postman (1) stated that in order to produce interference of the extra-experimental variety one needs to know what verbal associations the S brings to the laboratory. Underwood and Schulz (2) have provided Es with such information in their norms of associations between single letters, and between bigrams and single letters. The present experiment employed two lists that were intentionally designed to yield differential amounts of letter-sequence interference, and the results substantiated the prediction that strong letter-sequence habits in the LA list would inflate learning times. These data provide additional support for the letter-sequence hypothesis originally advanced by Underwood and Postman (1).

The authors realize that there is another possible interpretation of the results of the present study. It could be argued that what the present study has demonstrated is that materials of high meaningfulness (HA list) are learned more rapidly than materials of low meaningfulness (LA list). Such an interpretation is weakened considerably by the fact that some of the 3-letter units in the LA list are substantially more meaningful than some of the 3-letter units in the HA list. For example, according to Appendix B in Underwood and Schulz (2),

the meaningfulness association values for SBF and PHX of the LA list are 38% and 79%, respectively; while the corresponding units of SBX and PHF of the HA list have association values of 25% and 38%, respectively. Since meaningfulness values could not be obtained for all of the 3-letter units in the two lists, an interpretation in favor of differential meaningfulness may have some validity, although the authors prefer an interpretation in favor of differential letter-sequence interference.

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Studies of Serum Lipids in Cardiovascular Disease

Abstract—Sera from normal subjects and patients with cardiovascular disease were analyzed for total serum cholesterol and triglycerides; low-density lipoprotein cholesterol, triglycerides and protein. The low-density lipoproteins were separated from the high-density lipoproteins by precipitation with dextran sulfate and calcium chloride. The results showed that the ratio of cholesterol to protein in the dextran sulfate precipitable material remained relatively constant. It would appear that a slow increase in the low-density lipoprotein cholesterol concentration was accompanied by a corresponding increase in the protein moiety. This is in agreement with previous studies on experimental animals (1). No difference in the cholesterol to protein ratio of the dextran sulfate precipitable material of normal subjects and those with cardiovascular disease was obtained. No apparent relationship was found between the triglyceride concentration and protein content of this fraction.

It was shown in a previous study that if the concentration of cholesterol in serum was increased rapidly, e.g., by feeding cholesterol to rabbits, or feeding cholesterol with cholic acid to rats, the cholesterol to protein ratio of the dextran sulfate precipitable material increased markedly (1). Since these experimental conditions are known to lead to atherosclerosis in animals, we wondered if it would be possible to correlate variations in the cholesterol to protein, or triglyceride to protein, ratios of the dextran sulfate precipitable material in the serum of subjects with arteriosclerosis or other evidence of cardiovascular disease in man.

Although the experimental evidence suggests that dextran sulfate and calcium chloride precipitates only the low-density lipoproteins (2), it is quite possible that this may not always be the case. Consequently, we refer to this material as the dextran sulfate precipitable material (DSP) rather than as low-density lipoproteins. The non-precipitable material represents primarily high-density lipoproteins. The cholesterol values obtained for the non-dextran sulfate precipitable material are generally in good agreement with those given in the literature for high-density lipoproteins. It is quite possible, however, that they are not always equivalent. We have found young male subjects, as well as a few others, in which all of the serum cholesterol was precipitated by dextran sulfate. There was no reason to suspect

that these subjects had Tangier disease, a condition in which high-density lipoproteins are low or absent (3). Actually 8 of the 21 normal male subjects showed non-dextran sulfate precipitable cholesterol concentrations below 20 mg/100 ml of serum. The lowest value for the 33 young females was 25 mg/100 ml. Comparable differences between the sexes was also evident in the older normal groups and to some extent in those with cardiovascular disease.

Methods

One ml of serum was transferred to a heavy walled glass stoppered centrifuge tube of about 12 ml capacity. 0.04 ml of a 5% dextran sulfate solution was added, followed by 0.1 ml of an 11.1% solution of calcium chloride. The tubes, after gentle mixing, were set aside in a refrigerator. If the lipid concentration was expected to be quite elevated, the serum was diluted with 1 ml of a 0.9% solution of sodium chloride and the volume of dextran sulfate and calcium chloride doubled. The tubes, after standing in a refrigerator overnight, were centrifuged for about 30 minutes in an International centrifuge at about 2000 rpm. The supernatant fluid was carefully decanted and the tubes carefully inverted over filter paper to drain. A considerable amount of the inside of the tube was then dried with a roll of filter paper. Cholesterol and triglycerides were determined on the precipitate using a procedure described previously (4). In the tubes to be used for protein determination the precipitate was dissolved in 2 ml of 0.9% sodium chloride with careful washing down of the sides of the tube. The lipoproteins were precipitated as before. Solution and reprecipitation was repeated once more to make sure that all the non-precipitable proteins had been removed. The protein content of the final precipitate was determined using the procedure of Thrift and Forbes (5). Serum cholesterol was determined by a procedure described previously (6) adapted for a photoelectric colorimeter. Color development was carried out in the dark at 22°C. Matched tubes were used and each tube served as its own blank, a blank reading being taken prior to addition of the sulfuric acid for color develop-

TABLE I

Serum Cholesterol and Triglycerides: Dextran Sulfate Precipitable Cholesterol, Triglycerides, and Protein in Normal Subjects

Cholesterol (Ave. & Range)		Triglycerides (Ave. & Range)		DSP# Protein (Ave. & Range)	Number & Sex
Serum	DSP#	Serum	DSP#		
mg/100 ml	mg/100 ml	mg/100 ml	mg/100 ml	mg/100 ml	
180 (150-198)	137 (97-162)	79 (35-158)	64 (31-188)	106 (76-129)	19 F*
223 (208-243)	164 (121-191)	92 (46-149)	82 (30-145)	111 (77-144)	10 F*
271 (261-289)	228 (188-245)	90. (68-121)	78 (62-120)	168 (140-208)	4 F*
164 (125-196)	142 (95-196)	94 (36-158)	90 (36-158)	106 (76-129)	10 M**
220 (204-231)	180 (125-204)	111 (71-230)	109 (56-230)	111 (77-144)	7 M**
294 (240-339)	243 (227-278)	166 (81-255)	162 (81-254)	164 (144-192)	4 M**
176 (160-194)	154 (119-180)	100 (84-117)	76 (56-101)	105 (82-126)	13 M***
225 (203-244)	196 (171-216)	116 (81-146)	94 (46-146)	120 (114-163)	9 M***
282 (251-298)	249 (223-280)	161 (71-364)	142 (56-350)	162 (129-196)	5 M***
348 (318-380)	299 (241-378)	169 (101-417)	148 (82-382)	194 (139-258)	12 M***
362 (284-409)	275 (220-380)	135 (90-158)	117 (70-158)	205 (149-249)	6 F***

Dextran sulfate precipitate

* Females 18-31 years of age

** Males below 40 years of age

*** Males and females over 40 years of age

TABLE II

Serum Cholesterol and Triglycerides: Dextran Sulfate Precipitable Cholesterol, Triglycerides, and Protein in Subjects with Cardiovascular Disease

Cholesterol (Ave. & Range)		Triglycerides (Ave. & Range)		DSP# Protein (Ave. & Range)	No. & Sex	Diagnosis
Serum	DSP#	Serum	DSP#			
mg/100 ml	mg/100 ml	mg/100 ml	mg/100 ml	mg/100 ml		
324 (198-437)	301 (168-401)	217 (77-450)	198 (59-396)	206 (111-258)	25 M	A
375 (288-506)	334 (211-462)	382 (104-717)	269 (64-602)	211 (174-263)	9 F	A
327 (189-421)	279 (168-401)	218 (77-519)	178 (59-339)	187 (111-238)	15 M	B
384 (288-505)	309 (211-462)	237 (77-719)	187 (64-602)	194 (133-295)	8 F	B
378 (189-411)	330 (168-364)	253 (114-364)	228 (98-343)	218 (111-224)	10 M	C
338 (243-406)	294 (211-373)	232 (77-609)	190 (64-566)	203 (133-258)	13 F	C
333 (214-403)	292 (188-345)	283 (187-519)	247 (164-343)	198 (164-227)	9 M	D
344 (143-418)	287 (121-373)	190 (83-332)	166 (73-251)	191 (90-244)	12 F	D

Dextran sulfate precipitate

A Myocardial infarction

B Arteriosclerotic heart disease

C Angina

D Hypertensive heart disease

ment. Neutral fat was determined using a minor modification of the method of Van Handel and Zilversmit (7).

Results obtained on subjects without evidence of cardiovascular disease are shown in Table I. The results are divided into groups depending upon the serum cholesterol concentration and to some extent on age. It will be noted that there is a definite tendency for the concentration of the dextran sulfate precipitable protein to rise along with cholesterol. This is in agreement with our previous results on animals (1). These results, as well as those reported previously, suggest that the concentration of the "carrier protein" is related to the need for cholesterol transport, probably from the liver. The amount of serum triglyceride not precipitated by the dextran sulfate was, as expected, low in the young subjects of both sexes. The older subjects, especially the males, tended to show more non-dextran sulfate precipitable triglycerides. The significance of this, if any, remains to be determined.

Results obtained on subjects with various diagnoses of cardiovascular disease are shown in Table II. The same general relationship between cholesterol concentration and dextran sulfate precipitable protein was also evident here. No apparent relationship between triglyceride and protein concentration was seen.

Conclusion

The results did not show any apparent difference in cholesterol or triglyceride to protein ratios of the dextran sulfate precipitable material which could be correlated with any particular form of cardiovascular disease. It would appear that the slow increase in dextran sulfate precipitable cholesterol, as well as in serum cholesterol with age, was usually associated with a corresponding increase in the "carrier protein" so that no definite increase in the ratio of cholesterol to protein resulted.

Acknowledgement

We are indebted to Drs. Emmett C. Mathews and William T. Tucker for providing sera from their patients.

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News and Notes

PHYSICS DEPARTMENT STRENGTHENED AT COLLEGE OF WILLIAM AND MARY

The physics department of the College of William and Mary will undergo major strengthening over the next three years as part of an effort to make it one of the nation's leading research and educational centers in the field. The development will take place with the support of a new \$610,000 grant from the National Science Foundation under its departmental science development program. The \$610,000 grant is the largest ever to be received by William and Mary from the federal government, except for construction funds. The three-year program will involve purchase of more than \$250,000 in additional equipment, funds for visiting faculty, postdoctoral associates, summer salaries, graduate and undergraduate assistance and added technical help. It provides for consultants, additional library resources, symposia and conferences, and guest speakers.

In making the grant, the NSF recognized that "The welfare of the nation requires the development of additional academic centers capable of high quality research and education in the sciences." The NSF said similar departmental support grants were made to science departments at eleven other institutions, although no others were awarded to physics departments. Dr. Rolf G. Winter, chairman of the Physics Department, said the grant is "a genuine tribute to all elements of the College. None of this would have been possible without the help of undergraduate, graduate students, faculty and administration. The grant is of course closely connected to graduate work, but the undergraduate aspect is very important too. The NSF visitors were impressed by the quality of our undergraduates and their enthusiastic involvement in their research projects." Dr. Winter said the development plan does not involve the introduction of specialties in which the department does not currently have competence. "We seek simply to move forward from our present position in the most obvious ways in order to increase the strength of our research areas," he said. These areas include atmospheric physics, atomic and molecular physics, elementary particles and fields, nuclear physics, plasma physics, and solid state physics.

The department currently has 25 faculty members and three research associates. About 400 students are enrolled in its introductory courses. It has about 35 upperclassmen concentrating in the field, and about three-fourths of its seniors go on to do graduate work. There currently are 37 full-time and 19 part-time graduate students in the department. It is housed in the six-year-old William Small Physical Laboratory, a part of William and Mary's new campus. In addition, staff members use the Space Radiation Effects Laboratory in Newport

News, operated by William and Mary physicists for the National Aeronautics and Space Administration.

The physics department first began offering graduate work in 1959 with a Master's degree program. In 1964, it was authorized to begin offering work toward the Ph.D. degree and the first such degree was conferred in June, 1967. Eight physics Ph.D.'s have been conferred so far.

ROANOKE COLLEGE SCIENCE CENTER

The new \$3,900,000 Science Center, one of the newest facilities on the Roanoke Campus, will be dedicated Saturday morning October 17, 1970. An open house for invited guests will follow in the afternoon. A second open house, for the entire community, is to be held on Sunday, October 18. The college's physics, chemistry, biology, and psychology departments are expected to move into the Science Center for classes starting September 10, 1970. Classroom space at the College will be doubled by the Center's opening.

PROFESSORS EMERITI

Among eight faculty members of the University of Virginia retired on June 30, 1970 and named professor emeritus, were Drs. Alfred Burger and Robert E. Lutz, professors of chemistry, and Dr. W. Ralph Singleton, Samuel Miller professor of biology. Only those professors who have been full professors at the University for 15 years prior to retirement are elected professor emeritus.

Dr. Burger is the author of more than 100 articles on the chemistry of drugs and is probably best known for his work in developing tranquilizers and drugs for treating the emotionally disturbed. He received the 1967 pharmaceutical award in chemistry from the American Pharmaceutical Association Foundation and the Louis Pasteur Medal from The Pasteur Institute in Paris in 1953. In 1964 an annual lecture in the Department of Chemistry at the University of Virginia was named in his honor.

Dr. Lutz has directed the research of more than 75 doctoral students and has published more than 180 research publications. He has been honored by two sections of the American Chemical Society, receiving the Distinguished Service Award from the Virginia section in 1964 and an award for significant contributions to the advancement of chemistry from the Georgia section in 1970. He is a member of the Virginia Academy of Science.

Dr. Singleton is an internationally known geneticist who combined his interests in science and agriculture. Director of the University of Virginia's Blandy research farm from 1955 to 1965, he is known for his experiments with the effects of radiation on corn. As a consultant for the International Atomic Energy Agency, he went to Thailand in

1964, and in 1968 went to the Philippines for the U. S. Agency for International Development.

PROMOTIONS

Edward S. Harlow has been named Vice President, Quality Control, The American Tobacco Company. The announcement was made July 1, 1970, by Robert B. Walker, Chairman and Chief Executive Officer.

Mr. Harlow has been Managing Director of the research center since 1967. He joined the Company in 1931 as a research chemist, was appointed research coordinator in 1946, Assistant Laboratory Manager in 1955 and Assistant Managing Director in 1959. He is the author of a number of scientific publications on the nature and chemical composition of tobacco and tobacco smoke.

Ed Harlow has been active in the Virginia Academy of Science for many years. He was President 1956-57 and is currently Chairman of the Trust Committee and of the Ad Hoc Committee on Museum of Science.

John H. Hager has been appointed Research and Development Director for The American Tobacco Company's Department of Research and Development in Richmond, and we are pleased to welcome him back to Virginia. Prior to the announcement on July 1, 1970 he was Assistant to the President of The American Tobacco Company. He was transferred to New York from Richmond in 1969 as Marketing Coordinator. Previously he was assistant to the Director of Manufacturing and before that was Coordinator, New Products Division, Department of Research and Development in Richmond. He was transferred to the Virginia Branch in 1962 as Assistant Foreman and appointed Assistant Superintendent of the Virginia Branch the following year. Before his transfer to the New Products Division in 1964, he was Assistant Superintendent of the Reidsville Branch in Reidsville, North Carolina. Mr. Hager has a B.S. degree in Mechanical Engineering from Purdue University and an M.B.A. degree from Harvard University.

ASSOCIATION OF ACADEMIES OF SCIENCE

The Association of Academies of Science (until 1970, known as the Academy Conference) is an organization comprising all of the state and municipal Academies of Science. It meets annually as a section of the AAAS.

Officers of the Association that have come from Virginia are:

- 1938 Chairman—E. C. L. Miller
Vice-Chairman—B. Cunningham
- 1939 Chairman—B. Cunningham
- 1950 Chairman—B. Harshbarger
- 1956 President-elect—Thelma Heatwole
- 1957 President—Thelma Heatwole

The Chairman of the American Junior Academy of Science for 1966, 1967 and 1968 was E. L. Wiseman, Director of The Virginia Junior Academy of Science.

NEW BUSINESS MANAGER

We are pleased to announce that Dr. Charles E. O'Rear, Coordinator, Food and Drug Laboratory of the State Department of Agriculture and Commerce, has assumed the duties of Business Manager of the Virginia Journal of Science. Thomas H. Vaughan, Jr., who has been doing such an excellent job for the Journal as Business Manager, and previously as Assistant Business Manager with Blanton M. Bruner as Business Manager, has found it necessary to resign. The Editor takes this opportunity to thank Tom Vaughan for his invaluable assistance with the Journal.

Handbook of Atomic Elements

By R. A. WILLIAMS
Philosophical Library,
New York, 1970
125 pages, \$6.00

According to the Introduction, "*The Handbook of Atomic Elements*" is specifically designed to contain the most important, or at least the most often used, measurements or parameters pertinent to the elements and their classification into periodic categories.

The elements, ranging from Hydrogen at atomic number 1, through Lawrencium, atomic number 103, are arranged in alphabetical order. . . .

The physical values are grouped for ready use and include the following coverage of data: the name of the element and its atomic symbol; the principal quantum no., n(period); atomic number; atomic weight; X-ray notation; group; category; state; origin; the number of protons and electrons; the valence(s); the subshell filling; atomic, covalent and ionic radii; the ground state electron configuration; valence electrons; core member; and acid-base properties. Also included are the atomic volume; density; type of crystal structure; the electronegativity and electrical conductance; first ionization energy; ionization potential; heat of vaporization and fusion; and specific heat. Also, thermal conductance, boiling point and melting point. Radioactive isotopes are listed and their half-lives accompanied by the emission particle."

One of the best things that can be said about the book is that it does exactly what the introduction says it will do.

In this reviewer's experience there is a tremendous need for good compilations of data of all kinds. Unfortunately, this book does not contribute to fulfilling that need since it does not contain any critical evaluation of the data nor any bibliography. There is only one value given for each datum reported and anyone who has ever searched the literature for even a simple boiling point knows that such an ideal state of affairs does not exist, rather one finds many values for a given datum. In this respect the book is downright misleading in that it might lead one to believe that only one value for a given physical property has ever been reported. The omission of any semblance of a critical evalua-

tion of the data as well as the omission of any bibliography or references to original sources vitiates the book for serious work. Individuals desiring a superficial and misleading compilation of informa-

tion readily available from other sources are hereby notified of the book's availability, others are warned.

JAMES E. WORSHAM, JR.

VIRGINIA ACADEMY OF SCIENCE

FORTY-EIGHTH ANNUAL MEETING, RICHMOND

MAY 6-8, 1970

SUMMARY OF COUNCIL MEETINGS

Council met Wednesday, May 6, 1970, President Carpenter presiding and again on Friday, May 8, 1970, President Rowe presiding.

On May 6 President Carpenter reported on actions of the Executive Committee. He summarized discussion on time and place of annual meetings as follows:

1. The annual meeting should continue to serve as a joint meeting of the junior and senior academies.

2. Geographical limitation of meeting places to a few specific locations was undesirable.

3. The advantages of meeting space, food service, etc. on college campuses are sufficient to consider vacation period meetings although no improvement in housing results.

4. The Executive Committee by its continuity and experience remains the logical group to act as a place of meeting committee.

5. A detailed check list, different for college *vs* hotel meetings, should be prepared for submission to and discussion with the hosts prior to accepting an invitation.

6. The Executive Committee should make informal contacts with prospective host institutions in various areas probably 6 or 7 years in advance. This should be done with well known Academy members at these institutions.

Boyd Harshbarger moved that these statements be accepted as guidelines for future action by the Academy. Paul Siegel seconded, and Council approved.

Dr. Harshbarger reported for the Finance Committee, and circulated a tentative Expense Budget for 1970. There was no discussion of this report.

FUTURE MEETINGS

President Carpenter reviewed negotiations with Old Dominion University, Virginia State College, the Golden Triangle and the Hilton Hotels in Norfolk relating to the proposed annual meeting there in 1974. Dr. Harshbarger requested information on room rates in Norfolk for senior Academy members. These were read from the correspondence. Council then approved the motion by James Midyette, seconded by Stanley Williams, to accept the invitation to meet in Norfolk in 1974.

President Carpenter read a letter from President Miller of Madison College extending an invitation to host the Academy's meeting in Harrisonburg in 1975. Dr. Wightman moved that the Academy

Officers make preliminary contacts according to the guidelines just adopted. Vera Remsburg seconded. The motion carried.

MUSEUM OF SCIENCE TRUSTEES

The report of the Museum of Science Committee was presented, and the list of names nominated for trustees of the Museum was read. The Executive Committee's discussion of this matter was reviewed. Maurice Rowe explained the procedure followed by the Governor in making appointments. He also suggested that Council should limit its recommendations to Professionals who have direct contacts with the Academy.

Dr. Wightman moved that an announcement, soliciting nominations from the membership, be made at the Academy Conference. Nominations were to be assembled by sections at their section business meetings and presented to Council for further action at its meeting on May 8. This motion was seconded by James Midyette and approved by Council.

Stanley Williams moved that nominations be restricted to scientists and science-educators. William Hinton seconded. Vera Remsburg then moved an amendment to the motion, that nominations be restricted to members of the Academy. The amendment was seconded by Peter Derks. Dr. Hinton's move for the question was approved. Council then approved the amendment. President Carpenter then ruled that the original motion carried the meaning that Council, in its future actions should consider only nominations of scientists and science-educators who were members of the Academy. Council then approved the motion.

CONSTITUTION

The proposed constitution was discussed. Dr. A. M. Harvill raised the question of the status of the Flora Committee as a standing committee. President Carpenter reviewed the discussion of this question by the Executive Committee. James Midyette reviewed the discussion of the Constitution Revision Committee. After discussion, Boyd Harshbarger moved that the Flora Committee be made a standing committee of the Academy. James Midyette seconded, and Council approved.

The question raised by Dr. Perry Holt concerning ultimate authority over the affairs of the Academy was then presented. Again, the discussion of the Executive Committee and the Constitution Re-

vision Committee were reviewed by President Carpenter and James Midyette respectively. Paul Siegel also reported on his conversation with Dr. Holt. James Midyette then moved that Article III, Section 1 of the Constitution be amended to add the following sentence: "The membership, through the Academy Conference provided by Section 2 of Article VIII, shall have ultimate authority over the affairs of this organization." Paul Siegel seconded the motion, which was then carried by Council vote.

James Midyette reviewed Article XV of the proposed Constitution. No discussion ensued.

On May 8, 1970, President Rowe presided. He appointed Dr. Harshbarger chairman of the Awards Committee. Dr. Roscoe Hughes and George Jeffers are also to serve on the committee.

Dr. Roscoe Hughes as chairman of the newly instituted committee on conservation and natural resources commented that his committee would eventually make recommendations to the Academy as to the proper action to be taken within the broad area of his committee and that perhaps there could be coordination with other conservation groups and possibly some suggestions as to appropriate legislation. He requested help and comments from all interested.

LOCAL ARRANGEMENTS

Drs. Arthur Burke and Addison Campbell of the local Arrangements Committee were thanked for the smooth functioning of the meeting. Dr. Turner moved with Dr. Siegel's second that thanks be extended to all the committee. It was unanimously passed. Dr. Burke made a few comments in which he noted the help of Dr. Mary Kapp and the cooperation of the hotel management.

There were 20 commercial exhibits this year. It was suggested that the commercial exhibitions be listed in the proceedings of the Academy in some way. Dr. Midyette moved that the exhibitions be listed in the program and that by doing this it would be an incentive to them to make a firm decision at an earlier date concerning their exhibits. Dr. Clarke seconded this motion and the vote was carried without a dissenting voice.

BOTANY

Dr. Flory moved and Dr. Campbell seconded a motion to accept Botany as a new section of the Academy. There was some discussion concerning restructuring of the life sciences into several sections but the motion carried. Stewart A. Ware has been elected by the botanists as their section chairman. Dr. Leonard Morrow is the council representative. A report of the section meeting was turned over to the secretary.

VIRGINIA MUSEUM TRUSTEES

A number of nominations were received from various sections for the Virginia Museum Board of Trustees to be appointed by the Governor. Considerable discussion developed over the most appropriate way for nominations to be presented.

Dr. Midyette moved that Dr. Roscoe Hughes' name be placed at the top of the list. This was passed by acclamation. Dr. Turner suggested that all names be submitted and that they be described as scientists eminently qualified to serve in this capacity. It was moved by Dr. Abbott and seconded by Dr. Clarke that President Rowe work over the list and in consultation with the Executive Committee take appropriate action. It was mentioned that geographical location and other similar considerations be reviewed. The motion passed.

BY-LAWS

Dr. Midyette suggested that current by-laws operate until the next Executive Committee meeting. New by-laws have been mailed to all members and therefore fulfill the requirement of a 30 day period before change made during the Academy conference. New by-laws may be legally adopted after this period.

EDITORIAL BOARD

Considerable discussion was evoked concerning section editors, the editorial board, and the Publications Committee. It was moved that the Editor and the Publications Committee should be considered in charge of publications including the Journal and that they should be given freedom to solve problems in an expeditious manner. This was duly passed by Council.

1974 MEETING

Dr. Grigg moved that the 1974 meeting date preferred by the host, Old Dominion University, and presented by Dr. Carpenter, be from April 30-May 3. This passed by a vote of 10-6.

ANNOUNCEMENTS

1. President Rowe mentioned the following as coming from the section chairmen's meeting.
 - a. need for assistance in mailings.
 - b. new membership application forms and follow-up letters to be sent to non-members who present papers.
 - c. abstract forms sent to section secretaries should be sent earlier and in larger quantity.
 - d. need for coordination between sections.
 - e. a set of rules and guidelines be furnished to section officers to expedite and coordinate their activities. This should include all dates and times for special mailings.
2. Dr. Rae Carpenter is to follow through on future meeting arrangements.
3. Dr. Wisman commented on the activities of the Virginia Junior Academy of Science and thanked senior members for their cooperation.

SUMMARY OF THE ACADEMY CONFERENCE

The Academy Conference convened at 11:30 a.m. on Thursday, May 7, 1970, President Carpenter presiding. The meeting was well attended. Reports of committees and sections were presented.

The president made the following announcements:

1. Council had approved the 1974 Annual Meeting in Norfolk.

2. Council was considering the invitation of Madison College to meet in Harrisonburg in 1975.

3. Nominations of Academy members for recommendation to the Governor as Trustees of the Museum of Science were solicited from members. Nominations are to be turned in to section officers at the section business meetings, to forward to Council for action at its meeting May 8.

4. Abstracts of papers are to be given to Lynn Abbott, Journal Editor.

5. Members were invited to the Phipps and Bird mixer in the hour preceding the banquet.

6. Section officers are to submit reports to Mr. Rodney Berry, President-Elect Rowe announced:

1. Council meeting, Friday May 8.

2. Section chairmen and secretaries to meet, Thursday May 7.

3. Expressed thanks to local arrangements committee for a job extremely well done.

NOMINATING COMMITTEE

The following report was received:

For Treasurer —Austin Grigg

For Secretary —Franklin Flint

For President-Elect —Edward Turner

No additional nominations were made from the floor, and a motion to close the nominations was approved. A motion to cast a unanimous vote in approval of the proposed slate of officers passed without audible dissent.

CONSTITUTION

President Carpenter explained the background leading to the proposed revision of the constitution. James Midyette added some explanatory remarks. The following typographical errors were then noted:

1. ARTICLE IX, Section 1, line 1 should read "Sections as defined in Article III"

2. ARTICLE X, Section 4, Part b, line 2 should read "provisions of Article VII"

3. ARTICLE XIII, Section 3, line 3 should read "in accordance with section 1"

The proposed constitution was then reviewed article by article. Except as follows, no changes were proposed.

1. Paul Siegel moved that the following statement be added to Article III, Section 1:

"The membership, through the Academy Conference provided by Section 2 of Article VIII, shall have ultimate authority over the affairs of this organization."

This motion was seconded by James Midyette and approved by voice vote with no dissenting votes heard.

2. Boyd Harshbarger moved that Article III, Section 6 be amended so as to insert "The Virginia Flora Committee" after the "Finance and Endow-

ment Committee" as a standing committee of the Academy. Motion carried.

3. John Forbes moved that Article XIII, Section 1 be changed so that the concluding words, "30 days prior to their effective date" should read "30 days prior to action by Council." The motion, seconded by Paul Siegel, carried.

Motion was then made by Boyd Harshbarger and seconded by Paul Siegel that the Constitution as read and amended be adopted. This motion was approved without dissent.

REPORT OF THE CHEMISTRY SECTION

A new emphasis has been added to the Chemistry Section of the Academy, as it is now sponsored as a joint meeting by Virginia Blue Ridge, Hampton Roads and The Virginia Sections of the American Chemical Society. This action by all of the local sections of the ACS in Virginia affords an opportunity to have one joint meeting to discuss mutual problems. Also by this sponsorship, the chemists in Virginia wish to indicate their continued interest and support of the Academy.

The program of the Chemistry Section this year consists of 28 papers from ten colleges and universities, plus five from the Virginia Institute for Scientific Research, The Naval Weapons Laboratory, The Research Triangle Park, North Carolina, and the Langley Research Center, making a total of 33 papers in all.

No problems have been presented which require Council action and the Section looks forward to another successful meeting.

Randolph N. Gladding
Council Representative

REPORT OF THE BUSINESS ADVISORY COMMITTEE

At the present time we have 35 business members of the Virginia Academy of Science. To date 27 of these members have paid their dues for 1970. During the last year one of the members merged with another company and its status is uncertain at this time. We again solicit the aid of any and all interested Academy members in obtaining business members. Only through this type of effort can we promote the Academy and make businesses aware of the significance of participating in this important endeavor. Again we would like to thank Mr. Rodney Berry for his great assistance in helping us to carry out the responsibilities of this committee.

Richard M. Irby, Jr., *Chairman*

REPORT OF THE TRUSTEES

The Trustees have reviewed the investments of the trust fund account at First and Merchants National Bank. As of February 26, 1970, the market value of the investments held was \$41,842. This is divided roughly one-third in bonds and two-thirds in common stocks. The estimated annual income is about \$2,600. The Trustees receive quarterly

reports from the bank and these are reviewed as rendered.

Edward S. Harlow, *Chairman*

REPORT OF THE LONG-RANGE PLANNING COMMITTEE

During the past year the Committee has met twice, in Charlottesville on 25 October and again on 26 April.

Primary concern at these meetings has been the possible facilitation of the organization of the Annual Meetings and establishment of a uniform manner for the appointment of committee and selection of chairman.

Equally important were the discussions on what course the Academy should follow in its relation to the State Government. What can the Academy do to help the State improve the Academic and Industrial Science posture in the State, and what can be done to improve the status of the sciences in the pre-college years?

A formal set of recommendations was submitted to Council at its fall meeting, and the Committee will be able to make further recommendations in the Fall of 1970. No specific recommendations are made at this time.

A. M. Clarke, *Chairman*

REPORT OF THE MEMBERSHIP COMMITTEE

The Membership Committee has tried to implement the stated duties and objectives of the committee during the 1969-70 academic year. The following activities were conducted in an effort to increase the number of active members:

1. A faculty member at each institution of higher education was contacted and asked to serve as a liaison representative for the committee toward an end of increasing the membership in the Virginia Academy of Science at his particular institution. Lists of faculty members were compiled and checked for active members by the committee. A report listing non-members of the Academy by institution was supplied to each institutional liaison person and special efforts were made to contact these people.

2. All four-year institutions of higher education in the state that were not sustaining members of the Academy as of September, 1969, were contacted directly and urged to participate in this activity. Existing sustaining members were asked to increase their contributions.

3. Efforts were made to solicit membership from the public school science teachers by setting up a booth and distributing information concerning the Academy at the Annual Virginia Science Teacher's meeting in Blacksburg.

The committee made no efforts to contact prospective members from business and industry, and it is the committee's opinion that this area represents an on-tap source of members which should be explored in the future.

Membership of the Academy was listed in the

March 31, 1969 financial statement at 1,731. The current membership is 1,767.

Daniel E. Marvin, Jr., *Chairman*

REPORT OF THE RESEARCH COMMITTEE

Early in the year arrangements were made with the Princeton University Chapter of Sigma Xi to evaluate the papers which would be submitted for the J. Shelton Horsley Award, Twenty-three papers were offered in the competition; seven in the field of Biology, four in Engineering, three in Chemistry, three in Statistics, two in Medical Science, two in Physics, one in Agronomy and one in Psychology. The winner will be announced at the VAS Assembly.

Two requests for research support were received during the year. One was approved by the Committee contingent upon submission of additional information which has not been received. Thus it has not yet been awarded. The second request was received May 4. It will be transmitted to the new chairman of the committee.

It is suggested that in the future the basis of eligibility for the Horsley Award be stated as follows: "Authors and co-authors applying for the award shall be members in good standing of The Virginia Academy of Science, but non-members may become eligible by joining the Academy before the closing date for receipt of manuscripts or papers." The current interpretation is that an individual must be a member of the Academy by the time of the award.

William M. Hinton, *Chairman*

REPORT OF THE VIRGINIA JUNIOR ACADEMY OF SCIENCE

There are three main quantitative measures for determining the success each year of the Virginia Junior Academy of Science program. These are (1) number of member schools, (2) number of research papers submitted for presentation at the annual meeting and (3) attendance at the annual meeting. Based on these three objective criteria, it is apparent that 1969-70 has been another successful year for the VJAS.

The number of member schools this year was 132, compared to 115 last year, the number of papers submitted was 285 compared to 278 last year, with 165 being selected each year for presentation. Registration at the annual meeting slightly exceeded 700; 600 were students. These numbers are comparable to those for last year.

Quality-wise, the committee is in agreement that the research papers presented this year were superior to those presented in recent years. This is, perhaps, a more significant measure of the effectiveness of the VJAS program than the numbers criteria.

The committee and student officers were very active throughout the year. All activities and projects cannot be given, but several should be mentioned. Another excellent *Proceedings* was published, two issues of the Junior Science Bulletin were published, and the *Handbook* was revised. No new awards have been added to the list, but it

should be recorded that the E. C. L. Miller trophy cup, the first one purchased, reached a significant milestone this year by being retired by Denbigh High School for winning the cup three years in succession. As a result, a new cup has been secured to continue the competition.

Two students again represented the VJAS at the American Junior Academy of Science Award meeting held in conjunction with the AAAS meeting last December in Boston, keeping intact the record of being one of only three states sending two participants to the AJAS every year since the first meeting.

Budget-wise, the VJAS operated at the same level as last year. Of the total \$7500, \$2500 of the money was provided by the VAS, \$2000 by an NSF grant, \$2000 by industry and individual gifts and the remainder by VJAS registrations. We feel that we are operating with adequate financial support and wish to express our thanks to all of our loyal and interested supporters. Special acknowledgement is given to the officers and members of the Senior Academy for their excellent support.

We are looking forward to a continued successful VJAS program next year.

E. L. Wisman, *Chairman*

REPORT OF THE FLORA COMMITTEE

The fall meeting at Lynchburg College set general guidelines for the publication of a flora of Virginia.

Four more botanists were added to the list of authors for the flora bringing the number to twelve.

Virginia collections continued to grow at a rapid pace and two more collectors were added to our field workers bringing the number to more than thirty.

Five papers and one book, the *Spring Flora of Virginia*, were published by members on distributional aspects of plants in Virginia, and three more parts of the bibliography of Virginia botany were compiled.

Gustav Hall, A. M. Harvill, Miles Johnson, and Gwynn Ramsey each worked on Virginian materials in one or more of the following herbaria: Gray Herbarium, New York Botanical Garden, Philadelphia Academy of Science, Smithsonian Institution, National Arboretum, North Carolina State, and the University of North Carolina.

A statement, with endorsements, in support of the Science Museum was prepared by Leonard Morrow, with the aid of several other Committee members, and distributed to members of the General Assembly.

A. M. Harvill, Jr., *Chairman*

REPORT OF THE PUBLICATIONS COMMITTEE

The most significant item to report this year is the long awaited start of publication of the articles dealing with different aspects of the Dismal Swamp. Articles on the Birds of the Swamp (by Dr. J. J. Murray) and the Forests of the Swamp (by Dr.

George Dean) appeared in the Fall 1969 issue of The Virginia Journal of Science. These excellent contributions have been received with considerable enthusiasm. Dr. Sam Obenshain has prepared a completely up-to-date article dealing with the Soils of the Dismal Swamp, which is now awaiting publication. Several other articles on the Swamp are in preparation or being revised, and it is anticipated that at least three of these will be in press by the end of the year. It is expected that within the next few years articles dealing with most natural and scientific aspects of the Swamp will be published.

The publications of the VJAS have continued to be of excellent quality and to serve their communication objectives in excellent fashion. Revision work on the final three chapters of the Academy History has continued, but has been slow; it is hoped these three chapters may be in press by the end of the present year.

Walter S. Flory, *Chairman*

REPORT OF THE SCIENCE TALENT SEARCH COMMITTEE

All of the students from Virginia who participated in the 29th Science Talent Search for the Westinghouse Science Scholarships and awards as conducted by the Science Clubs of America were automatically considered in the Virginia Science Talent Search.

Students from the 50 states and the District of Columbia competed in the 29th National Science Talent Search. Forty-three states and the District of Columbia hold State Science Talent Searches.

Virginia had 116 completed entries in the National Competition. The 116 students represented 49 different high schools situated throughout the state of Virginia. While Virginia did not have any students among the 40 National winners, Virginia did have twenty students from fifteen different high schools in the National Honors group of 300.

Virginia tied with California for fourth place in the number of students in the Honors Group, behind New York with seventy, Pennsylvania with twenty-two and Illinois with twenty-one.

Since the start of the annual Science Talent Search for the Westinghouse Science Scholarships and Awards in 1942, Virginia has had twenty-one National winners and 210 in the National Honors group.

116 entries were reviewed by a reading committee and 44 were selected as Virginia Finalists and invited to the annual meeting of the Academy. Thirty-nine attended and were interviewed. Fifteen were selected as Virginia Winners. Eighty-six scholarships were made available to state winners and honorable mention by 23 Virginia colleges and universities. These scholarships ranged from \$250.00 to \$3600.00 a year, renewable for succeeding years on the basis of satisfactory academic records. The monetary value of these scholarships was in the range of \$40,000.00.

Each contestant was given a \$10.00 check (coordinated with Junior Academy participants to prevent duplication) to help with expenses. The 15

winners were given checks for \$15.00 to be applied to the purchase of a scientific handbook.

Edgar V. Russell Jr., *Chairman*

REPORT ON VISITING SCIENTISTS PROGRAM

In the 1969-70 academic year the program was operated as in the previous year. The number of volunteers increased from 237 to 400 representing 27 schools and 1 State agency compared to 20 schools the previous year.

The speakers list was circulated in mid-October 1969 to each Division Superintendent and to one upper level science teacher in each state high school and to all private schools. It contained the names of 400 volunteers from 27 institutions plus the State Board of Education. There were 14 major topic areas listed. A summary is presented.

In May, reply post cards were sent to all 400 volunteers asking for a report on their visits including certain specific information on WHO spoke, to WHOM, WHEN, WHERE, and HOW MANY. Responses were received from 289 of the 400 (72%).

Visits were made by 68 volunteers in response to requests from high schools. These volunteers were from 24 institutions and represented 11 different major topics. The 68 volunteers made 98 separate visits, some visiting as many as 6 different schools. The basic sciences, biology, chemistry and physics, accounted for the topics in nearly two-thirds of the total visits. Specific data are presented.

In analyzing the data please keep in mind that no response was received from 111 of the volunteers. Most of these may be assumed to be negative replies but perhaps a few are not. These would increase the figures on each of the statistics given.

On behalf of the Academy, I thank each of the volunteers and the presidents of our supporting institutions. The number of students reached, according to the speakers' estimates was about 3800 in grades 8-10 and 3700 in grades 11-12. Counties and cities whose schools were visited numbered 40. You may be proud of the breadth and depth of this influence for science in Virginia. The Academy hopes to have your continued support in the 1970-71 school year.

D. Rae Carpenter, Jr., *Director*

Institution	Speaker Volunteers	Actual Visitors
Averett College	2	1
Bridgewater College	12	7
Clinch Valley College	4	3
College of William and Mary	11	2
Emory and Henry College	9	3
Hampton Institute	3	2
Hampden-Sydney College	8	3
Hollins College	6	0
King College	4	1
Longwood College	3	2
Lynchburg College	10	4
Madison College	9	3
Mary Baldwin College	1	0
Mary Washington College	9	3

Topics	Speaker Volunteers	Actual Visits
Astronomy	7	2
Biology	58	32
Chemistry	52	23
Computer Science	1	2
Economics	5	0
Engineering and Applied Science	18	1
Geological Science	14	10
Mathematics	33	3
Physics	46	6
Psychology	16	5
Sociology	9	6
Statistics	3	0
MCV (Medical Science)	65	8
Old Dominion Univ. (miscellaneous)	12	0
VPI (Agricultural & Engineering)	61	0
	400	98

Visits Made by Each Volunteer	Total
One	50
Two	12
Three	3
Four	1
Five	1
Six	1
None	221
No reply by postcard	111
	400
	98

One	Two	Three	Four	Five	Six	Seven	Unknown	Total
59	22	5	7	2	1	1	1	170

Cities and Counties Visited (Number in parenthesis indicates total if more than one.)

Augusta Co. (3)	Rockbridge Co. (3)
Appomattox Co.	Rockingham Co. (7)
Bath Co.	Russell Co.
Bedford Co. (3)	Southampton Co. (2)
Campbell Co. (2)	Warren Co.
Charlotte Co.	Washington Co.
Fauquier Co.	Wise Co. (4)
Frederick Co.	Wythe Co.
Giles Co.	
Greene Co. (8)	
Hanover Co.	Alexandria
Henrico Co. (3)	Fairfax
Isle of Wight Co.	Lynchburg
Lee Co. (2)	Newport News (7)
Montgomery Co.	Petersburg
Nansemond Co. (2)	Philadelphia, Pa.
Nelson Co.	Richmond (13)

Northumberland Co. (2) Williamsburg (4)
 Nottoway Co. Portsmouth
 Pittsylvania Co. (3)
 Prince William Co. (2)
 Pulaski Co. (3)
 Roanoke Co. (4)

Colleges	50.00	24	600	23	575
Colleges	100.00	1	50	1	50
Colleges	100.00	4	400	4	400
Business	100.00	34	3,400	36	3,600
Delinquent		3	15	4	20

1710 13,870 1723 14,190

14 1,750 20 2,500

Exhibitors \$125

Registrations:

Students \$1.50 } 80 120

Members \$3.00 } 1,006.50 500 1,500

Non-Memb. \$5.00 } 100 500

Dividends } 1,171.00 105

Interest } 950

Gifts, Grants, Misc. 2,405.00 2,150

Journal Income 5,525.00 5,000

Income from Foley Smith Fund 400

NSF Grant 2,000.00 2,000

TOTAL 28,784.00 30,615

Bequest—Foley Smith 8,000.00

TOTAL 36,784.00

INCOME

Dues:	Income for 1969		Estimated for 1970	
	No.	\$	No.	\$
Student	\$2-3.50	58	200	60 210
Regular	5.00	1381	6,905	1410 7,050
Contributing	10.00	155	1,550	156 1,560
Sust. Individual	25.00	30	750	29 725

TENTATIVE EXPENSE BUDGET 1970

	From Gifts, Fees, Adver- tising & Subs.	From General Fund	Total 1970	Spent 1969
AAAS (Dues, Reg. Fees, Travel)		300	300	36.08
VAS Annual Meeting		850	850	859.43
Honorarium Speaker		200	200	200.00
Va. Journal of Science (Subsidy including Proceedings)	5,000	6,700		
Printing History	650		12,350	11,744.34
Supplement of Funds Available to Journal (if available)	1,200		1,200	466.64
Program VAS Ann. Meeting-Roster of Members		740	740	642.57
Leaflet	425		425	342.16
Exec. Secy.-Treas.		1,800	1,800	1,800.00
Rent	600		600	600.00
Clerical & Office Expenses		1,200	1,200	672.22
Printing, Addressograph Services and Section Office Services		600	600	674.60
Stationery & Supplies	225		225	136.34
Postage	475		475	539.37
Telephone	175		175	94.48
Audit & Tax Service	500		500	945.60
Miscellaneous Expenses	100		100	84.00
History & Academy Expenses	75		75	00.00
Science Talent Search	450		450	407.85
VJAS (incl. publications)	5,000	2,500	7,500	7,452.75
E C L Miller Award		50	50	50.00
Contingency (President)		100	100	00.00
S. S. Taxes, Corp. Fee	115		115	79.48
Visiting Scientists Program	425		425	306.89
Science Teacher Award & other awards	100		100	200.00
Director of Academy Affairs and 50th Anniversary		1,800	1,800	
	11,850	20,505	32,355	28,334.80

J. SHELTON HORSLEY

RESEARCH AWARD

Dr. I. Gordon Fels, Division of Biochemistry,
 Virginia Institute for Scientific Research, Rich-

mond, Virginia, received the 1970 J. Shelton Horsley Research Award for his paper "A Model System for Molecular Aging and Senescence" presented in the Chemistry Section, Forty-eighth Annual Meeting, Virginia Academy of Science, Richmond, May 8, 1970.

IVEY F. LEWIS DISTINGUISHED SERVICE AWARD

The Ivey F. Lewis Distinguished Service Award, the highest award conferred by the Virginia Academy of Science, is presented periodically to an outstanding Virginia Scientist for significant contributions toward the activities of the Virginia Academy of Science. Known originally as the Virginia Academy of Science Meritorious Service Award, the name was changed in 1965 in honor of the Academy's first president.

The Virginia Academy of Science is privileged to present to Professor Roscoe D. Hughes the Ivey F. Lewis Distinguished Service Award for 1970. This year's recipient, a gentleman, scientist and scholar, has not only made substantial contributions to scientific knowledge and higher education but has given much of his time and energy enthusiastically and with devotion to the objectives and welfare of the Virginia Academy of Science.

He has held the following important positions with the Academy: President, 1965-1966; Chairman of the Research Committee, 1962-1963; Chairman of the Membership Committee and of the Nominating Committee, 1968-1969. He has served on numerous other committees and on the Council. He was Chairman of the Committee for the Symposium on "Exploring Virginia's Human Resources" presented at the Annual meeting of the Academy in 1964 and General Conference Chairman of the first Virginia Population Conference co-sponsored by the Virginia Academy of Science and held in Richmond in December 1966.

His persistent and unflagging efforts on behalf of The Science Museum of Virginia both within the Virginia Academy of Science and as the Governor's appointee to, and Vice-Chairman of, The State Museum of Science Study Commission, are well-known, and the Academy is deeply appreciative. Evidence of his tireless devotion to this cause is seen in the excellent, attractive publication of the report of the Virginia Museum of Science Study Commission submitted to former Governor Godwin by its Chairman, Senator William F. Parkerson, Jr., in October 1969, and in the creation of the Science Museum of Virginia by action of the General Assembly at its 1970 session.

Dr. Roscoe D. Hughes is a native of Dupont, Georgia. He was graduated from the U.S. Naval Academy in 1927 and Columbia University with the M.S. in 1937 and the Ph.D. (cytogenetics) in 1939. He went to the Medical College of Virginia as an

associate in biology in 1938, became assistant professor in 1940 and professor in 1944. He was on leave with the United States Navy during the war years, 1941-45, and holds the rank of Captain in the U.S. Naval Reserve (retired).

His research interests include the cytogenetics of *Drosophila* and *Acarina*, human genetics and human ecology. His "mitey" monograph published in 1958 in the *Virginia Journal of Science* received world-wide attention.

Although Dr. Hughes will retire from Virginia Commonwealth University as professor of genetics and chairman of the department in June, 1970, we anticipate that he will continue to be more active than ever in the affairs of the Virginia Academy of Science and in the furtherance of science and science education for the benefit of mankind.

SIDNEY S. NEGUS MEMORIAL LECTURE

Dr. Robert M. Wood, Deputy Director, Research and Development, Advanced Systems and Technology, McDonnell Douglas Astronautics Company, presented the annual Sidney S. Negus Memorial Lecture, "The Giant Discoveries of Future Science" at the Academy Assembly, May 7, 1970. The lecture will appear in a future issue of the *Virginia Journal of Science*.

FELLOWS OF THE VIRGINIA ACADEMY OF SCIENCE

The following members of the Virginia Academy of Science were elected Fellows by vote of the Council in session March 15, 1970 in accordance with the provision set forth in the Constitution, Article 4. Announcement was made at the Academy Assembly, Richmond, Virginia, May 7, 1970 and certificates were presented to those in attendance.

Jesse Wakefield Beams	University of Virginia
John Campbell Forbes	Medical College of Virginia
Thomas E. Gilmer	Hampden-Sydney College
Boyd Harshbarger	Virginia Polytechnic Institute
Roscoe D. Hughes	Medical College of Virginia
Clyde Young Kramer	Virginia Polytechnic Institute
J. Douglas Reid	Medical College of Virginia
William T. Sanger	Medical College of Virginia

Abstracts of Papers

Section of Agricultural Science

Forty-eighth Annual Meeting of The Virginia Academy of Science
May 6-8, 1970, Richmond, Virginia

COMPARISONS OF METHODS OF IDENTIFYING EXPERIMENTAL CATTLE:
FREEZE BRANDING AND PLASTIC EAR TAGS. K. P. Bovard, N. W.
Hoover*, and B. M. Priode*. Beef Cattle Research Station,
VPI and USDA, Front Royal, Virginia 22630

Copper alloy irons 1^{1/4}" high x 1^{1/8}" deep x 1^{1/8}" face were
cooled with liquid N₂ and freeze-brands were applied to
clipped and unclipped surfaces of 16 Angus yearling and 13
Hereford 2-year-old heifers in Nov. '68. Legibility was
scored in Sept. '69. Clipping prior to branding helped
subsequent clarity of Hereford brands, but harmed that of
Angus. In Nov. '69, smaller irons, 3^{1/2}" high x 1" deep x 1^{1/8}"
face, were used to apply a 5-digit number to unclipped hip
and upper rib area on each of 48 Angus heifer calves at
weaning. Legibility was subjectively scored in April '70 as
the number of digits clearly legible (i.e., perfect score
was 5.0). Mean values were 1.5, 3.2, 3.9, and 4.0 from
irons applied for 25, 30, 35, and 40 seconds, resp; 3.8 and
2.6 for operators with much and little previous experience,
resp; and 2.7 and 3.6 for inbred and non-inbred calves, resp.

Large plastic ear tags, > 1" x 2", of 3 manufacturers, A,
B, and C, were compared. In 1968, with 323 calves, losses
of brand A to weaning were 2%, weaning to one year, 1%.
Corresponding losses of brand B were 6% and 23%, resp.
In 1969, with 335 calves, losses of brand A tags to weaning
were 1%; to one year, 12%. Corresponding losses of brand C
were 1% and 9%, resp.

THE EFFECTS OF A SULFONYLUREA DRUG UPON VARIOUS HOMEOSTATIC
ORGANS IN PREGNANT AND NONPREGNANT RATS. G. L. Brubaker*
and T. N. Meacham.* Dept. of Animal Science, Va. Polytechnic
Institute, Blacksburg, Va., 24061.

Eighty DDR rats were used to determine the effects of a
sulfonylurea drug (chlorpropamide) upon various homeostatic
organs in pregnant and nonpregnant rats. Treated rats re-
ceived 33 mg chlorpropamide/kg of B.W. from day 2 to 12
after breeding and killed. Females were observed for pre-
natal mortality and reproductive tracts removed. Adrenal,
thyroid, liver, and blood samples were taken. Feces and
urine were collected from all rats. Feed consumption and wt
gains were recorded daily. The treated group had less ($P<.05$)
prenatal mortality. Treatment produced higher liver
($P<.01$) glycogen content. Thyroid wts. and cell height
were lower ($P<.05$) in the pregnant groups while thyroid
activity was higher. Thyroid wt was lower ($P<.05$) in the
pregnant and nonpregnant groups due to chlorpropamide.
Adrenal wts were higher ($P<.05$) in both the control and
treated pregnant rats. Daily feed consumption was lower ($P<.01$)
due to chlorpropamide. Pregnancy produced higher ($P<.01$)
feed consumption. Chlorpropamide reduced ($P<.01$) wt
gains while pregnancy increased ($P<.01$) wt gains. Nitrogen
retention was ($P<.01$) higher in both pregnant and non-
pregnant groups due to the drug and also ($P<.01$) higher in
the pregnancy group.

ULTRASONIC ESTIMATES OF HIDE AND FAT THICKNESS IN BEEF CALVES
ON POSTWEANING GROWTH TESTS AT FRONT ROYAL. K. P. Bovard
and B. M. Priode*. Beef Cattle Research Station, VPI and
USDA, Front Royal, Virginia 22630

Thickness of hide and fat were estimated using a Branson
Sonoray Model 12 on 143 heifers and 40 bull calves on a
growth test from October 1969 through March 1970 at the Front
Royal Station. Calves were from highly inbred and from non-
inbred selection lines of purebred Angus and Shorthorns.
Anatomical site of the measurements was a point on the calf's
loin behind the 12th rib, about 10 cm. left of the spine.
At weaning, estimated hide and fat thicknesses in bull calves
full-fed were, for 21 Angus: .55 and .26 cm., resp., for 19
Shorthorns: .68 and .23 cm., resp. Increments in the
succeeding 166 days were for Angus: .06 and .15 cm., and for
Shorthorns: .09 and .19 cm., resp. Corresponding values were
similar, but generally smaller in the heifer calves, limited-
fed. Duplicate readings on Angus heifer calves in January
and in March showed very small differences between readings
the same day, larger differences between lines of breeding,
and differences among calves were highly significant. Intra-
class correlation of $r^2_{\text{C}}/(r^2_{\text{C}} + r^2_{\text{E}})$ was 0.41 in January, and
0.47 in March. Test gain was lowly correlated with increase
in fat thickness, $r = 0.13$ in 42 bulls tested.

RESPONSE OF KY. 31 FESCUE TO SUMMER WEEKLY NITROGEN
APPLICATIONS IN SOUTHEASTERN VIRGINIA. D. L. Hallock,
Tidewater Research Station, V.P.I., Holland, Va. 23391

Rates of N up to 50 lb/a weekly were broadcast on well
fertilized (P and K) Ky. 31 fescue during the period May
through August 1966 to 1969. Average yields were 4000,
5800, 8900, 10,100 and 10,100 lb/a for the 0-, 5-, 20-,
35-, and 50-lb/a weekly N rates, respectively. Seasonal
yields of fescue allowed to head before the first spring
clipping were similar to fescue cut at about 9-inch height.
Irrigation during 1966 and 1967 did not increase yields or
protein content of the forage. Clipping level was back to
approximately 2.5 inches.

In 1969, stands in the high-N plots were similar to the
check plots. However, the 5-lb rate tended to improve
stands.

Protein content was highest in forage clipped at 9-inch
height and not allowed to head. Forage fertilized at the
0, the 5- and 20-lb rates, and the 35- and 50-lb rates
contained about 13, 20 and 25% protein, respectively. June
and August forage was considerably higher in % protein than
spring and fall forage, especially at the higher N rates.

EFFECT OF PROCESSING METHODS OF BROILER LITTER ON NITROGEN UTILIZATION BY LAMBS. B. W. Harmon^a, J. P. Fontenot, K. E. Webb, Jr.^a. Dept. of An. Sci., V.P.I., Blacksburg, Va. 24061

In previous work with broiler litter, approximately 20% of the total nitrogen was lost when litter was sterilized by dry heat. In this study, nitrogen loss was reduced by acidifying the litter to pH 6 prior to heating. Twelve wether lambs were used in two 20-day metabolism trials to study the relative effects of the following three methods of processing litter on nitrogen utilization: 1) autoclaving under steam pressure of 1.06 kg/cm² for 40 min.; 2) heating in a forced draft oven at 150°C for 4 hr; and 3) acidifying with 30 ml 1.0 N H₂SO₄ per 100 g of litter prior to heating. Four rations were used containing similar levels of crude protein (%), crude fiber, calcium and phosphorus. Soybean meal supplied 50% of the nitrogen in the control ration. Broiler litter nitrogen replaced the soybean nitrogen in the three experimental rations. Nitrogen retention was higher for the animals fed the control ration. Method of processing litter had no substantial effect on nitrogen retention. Rumen fluid pH and ammonia level were not affected by treatment. Blood urea level was not affected by treatment. Crude protein and dry matter digestibilities tended to be higher for the control ration, with no marked differences among the rations containing litter.

COMPARISON OF COPPER, IRON, ANTIBIOTICS AND STREPTOCOCCUS FACIUM FOR SWINE GROWER RATIONS. E. T. Kornegay and H. R. Thomas. Dept. of Animal Science, Va. Polytechnic Inst., Blacksburg, and Holland, Va. 24061 and 23391 resp.

Seven trials using four hundred crossbred growing pigs varying in initial weight from 12 to 64 lb. were used to study the effect on body weight gain, feed intake, feed efficiency and hemoglobin of copper, iron, antibiotics and *S. facium* added to fortified corn-soybean meal grower rations fed ad libitum. Trials lasted from 4-12 weeks.

In trials 1-4 comparing a combination of neomycin sulfate and terramycin (100 gm of each/ton) and *S. facium*, there was a significant increase in gain and feed intake of pigs due to the addition of neomycin sulfate-terramycin to the ration. There was only a slight improvement in feed efficiency. The addition of a *S. facium* concentrate to the ration did not significantly improve gain, feed intake or feed efficiency when compared to the control pigs.

In trials 5-7, gain of pigs was improved when 150 ppm copper was added to the ration; however, the difference was only significant in trial 6. Feed intake, feed efficiency and hemoglobin values of pigs were not different when copper was added to the ration. The addition of iron to the ration at 40 or 80 ppm had no influence on gain, feed intake, feed efficiency and hemoglobin. An evaluation of the data according to length of time on trial showed that antibiotics and copper were more effective during the first part of the trials.

RELATIONSHIP BETWEEN DIETARY NITRATE LEVEL AND VITAMIN A METABOLISM. R. E. Lichtenwalner^a, J. P. Fontenot and K. E. Webb, Jr.^a. Dept. An. Sci., V.P.I., Blacksburg, Va.

An experiment was conducted with 12 beef calves to determine the effect of feeding high levels of potassium nitrate (KNO₃) on vitamin A metabolism and blood methemoglobin levels. The calves, averaging 174 kg initially, were paired by sex and weight and allotted to a control or control plus KNO₃ ration. They were individually fed the respective rations twice daily. Level of KNO₃ in the experimental ration was varied in an attempt to maintain average methemoglobin levels at approximately 20% of total hemoglobin. Dietary KNO₃ level ranged from 2 to 6% during the trial. Blood methemoglobin levels were determined weekly and vitamin A and carotene levels in blood plasma and liver were determined in October (initial), November, December, February and March. Feed intake, rate of gain and feed efficiency were lower ($P < .01$) for the nitrate-fed cattle. On the twice daily feeding schedule, blood methemoglobin peaked approximately 2.5 hours after feeding. Average blood methemoglobin levels for the cattle fed the KNO₃ ration ranged from 3.7 to 49.3% during the trial with a mean of 17.2%. Rate of liver vitamin A depletion and plasma vitamin A levels were not significantly affected by level of KNO₃. Liver and plasma carotene values were higher in the nitrate-fed cattle throughout the trial, but the differences were not always significant.

CORN YIELDS AS RELATED TO PLANTING GEOMETRY. G. D. Jones, E. W. Carson, and J. A. Lutz, Jr. Dept. of Agronomy, Va. Polytechnic Inst., Blacksburg, Va. 24061

Experiments were conducted in Virginia in 1969, using a new technique developed at the University of Kentucky, to study the effects of plant populations, row spacings, and varieties on the yield of corn.

The technique consists of planting the corn in a wagon-wheel design. The rows, therefore, become closer together near the center of the experimental area. Plants within and between rows are spaced so that each will be nearly the same distance from the adjoining plants. One wagon wheel, with a diameter of 70 feet, contains 72 radii rows.

Planting corn at the optimum population should produce the highest yields because of maximum light interception, less water loss by evaporation, less competition among crop plants for nutrients and moisture, and less competition from weeds.

The highest yields were obtained at the higher plant populations. There was a variety by planting population interaction, and no variety differences were observed at populations below 17,000 plants per acre. With early varieties, higher populations were required to give maximum yields.

CAUSES OF EXCESSIVE SHRINKAGE OF STEAM-TREATED RED OAK WOOD. E. J. Kubinsky, Dept. of Forestry & Wildlife, Col. of Agric., Va. Polytechnic Inst., Blacksburg, Va. 24061

Investigations carried out at V.P.I. showed that already short steaming periods such as 6 hrs substantially increase (by 17% in the tangential and by 30% in the radial direction) the shrinkage of red oak wood, while prolonged steaming periods such as 96 hrs result in such an excessive (by 252% and 34% resp.) shrinkage that it is tantamount to a collapse. Simultaneously it was found that this collapse develops despite careful drying at room temperature and at increased relative humidity.

As a result of the steaming a significant decrease of the FSPL in compression perpendicular to the fiber direction was noticed at the initial high M_c, which was considered to account partly for the collapse.

Also, the leaching out of the extractives, abundantly present in the wood of most oaks, was taken into consideration as a possible contributing factor.

A microscopic analysis of the diameters of fibers and their lumina showed that due to the steaming an increase in internal swelling took place, which would indicate that the restraining effect of the tertiary wall against such a swelling was modified by some degradation in the assumed lignin-carbohydrate bonds in this layer. An increased swelling into the lumina would thus provide a more complete explanation for the mechanism of the observed excessive shrinkage.

FECUNDITY OF HETERODERA VIRGINIAE ON SIXTY-THREE LINES OR VARIETIES OF NICOTIANA TABACUM. L. I. Miller. Dept. of Plant Path. & Phys., V.P.I., Blacksburg, Va. 24061.

An isolate of the horsetail cyst nematode from Suffolk, Virginia, was tested to determine its ability to develop egg-bearing females on 63 lines or varieties of tobacco to include flue-cured(F), dark-fired(D), burley(B), Connecticut shade(GS) and sun-cured(S) types. One hundred cysts containing 120-185 eggs/egg were introduced into cyst-free soil in 4-inch pots. A single two-month-old seedling was transplanted to each pot and grown at air temperatures of 23-27°C. Each entry was replicated four times and the fecundity rating of the line or variety was based on the replicate supporting the best reproduction. After 5 weeks the soil was screened for females. Reproduction of the nematode was poor (0-9 females/plant) on FCoker(C)298, DNance, B1, B2, BK12, BK16, BK35, CSG, CSW, CS49 and CS2238. A medium number of females (10-29/plant) were formed on FMcNair(McN)20, FMcN561, FMcN521, FSpleight(SP)7, FNC95, FNC2512, FNC2514, FNC3909, FVA1766594M, B21, DVA2506. Numerous females (>30/plant) were formed on FC258H, FC187-Hicks, FC65188M, FC65254M, FC623234S, FC652153, FC652153, FMcN4, FMcN30, FMcN4691, FMcN532, FSPLG1, FSPLG1, FSPLG2, FSPLG2, FSPLG3, FSPLG4, FPDS, FPDS, FPDS, FPDS, FPDS, FNC2326, FN303C, FNC5055, FNC162653C, FVA614, FVA115, FVA216, FVA2252, FVA3149, FVA3160, FVA21766558A1, FBE1193, FHicks60E, BVA2523, DVA312, DVA3317, and SLSRorino.

FECUNDITY OF THE UNDESCRIPTED OSBORNE'S CYST NEMATODE ON SIXTY-TWO LINES OR VARIETIES OF *Nicotiana tabacum*. L. I. Miller and L. Spasoff*. Dept. of Plant Path. & Phys., Va. Polytechnic Inst., Blacksburg, Va. 24061.

An isolate of the Osborne's cyst nematode from Scotts Fork, Virginia, was tested to determine its ability to develop egg-bearing females on 62 lines or varieties of tobacco to include flue-cured (F), dark-fired (D), burley (B), Connecticut shade (CS) and sun-cured (S) types. One hundred cysts containing 110-120 eggs/cyst were introduced into cyst-free soil in 4-inch pots. A single two-month-old seedling was transplanted to each pot and grown at air temperatures of 23-27°C. After 5 weeks the soil was screened for females. Reproduction of the nematode was poor (0-9 females/plant) on FVA0211C, DVA2624, DVA2626, DVA3317, BVA-0570, BVA2508, BVA2509, BVA2552, DVA2564, DVA2575, BVA2701, BVA2703, BVA2705, BVA2706, BVA2708, B21 and BK25. A few females (10-20/plant) were found on FVA45, FVA0224F, FPP8, FNC2326 and BVA2538. A median number of females (21-79/plant) were found on FSPG17(GP)C27, FSPG29, FMcNair(McN)-20, FMcN30, FMcN5321, FCooker(C)651588M, FC65254M, FG652135, FPD5, FPD335, FPG24, FVGGold, FVA2252, FVA160, DNance, DLT-Droso, DVA312, CS6, CS9, CS223 and SLSorinco. Numerous females (<80/plant) were found on FSPG17, FSPG36, FSPG41, FMCN561, FMCN4194, FMCN4691, FG62323248, FPD7, FPD51, FNC95, FNC3503 and FGreensboro Hicks.

EFFECT OF EXOGENOUS ACTH ON CERULOPLASMIN LEVEL IN RABBIT SERUM. Dennis Rowan* and T. N. Meacham*, Dept. of Animal Science, Va. Polytechnic Institute, Blacksburg, Va.

Nature New Zealand White females were used in Trials I, II and III. Immature males and females were used in Trial IV. All doses of ACTH were given i.v. at the rate of 1 I.U./kg. B.W. except where noted in Trial II.

Trial I. Twelve does were divided into 3 groups: (1) control, (2) frequently bled control, and (3) ACTH treated. Group 1 was bled at 0 and 24 hrs. Groups 2 and 3 were bled at 0, 6, 12 and 24 hrs. Groups 1 and 2 showed a 9% increase in ceruloplasmin activity during the 24 hr. period, while the ACTH group showed a 24% increase during the same interval.

Trial II. Six does served as controls and 6 received injections immediately following bleeding on days 0 (S.C.) and 1 (I.V.). Sera were collected on days 0, 1, 2, 4, 6 and 13. Peak ceruloplasmin activity was at day 3. Activity remained high through day 6 but returned to a lower level by day 13.

Trial III. Ten does were used to establish the time of peak activity following a single dose of ACTH. Blood samples were taken at 0, 24, 36 and 48 hrs. The 5 treated animals showed a 49% increase at 24 hrs. with the concentration remaining relatively constant throughout the remaining 24 hrs.

Trial IV. Sixteen rabbits 7 to 8 weeks of age were used to test the effect of a single dose of ACTH upon ceruloplasmin activity 48 hrs. later. Treated animals showed a 21% increase in activity.

DUTCH ELM DISEASE: SYMPTOM EXPRESSION BY SOIL-INCORPORATED FUNGICIDES. R. J. Stipes. Dept. Plant Pathology and Physiology, Va. Polytech. Inst., Blacksburg, Va. 24061.

Four fungicides were assayed for control of Dutch elm disease in field-grown American elms (*Ulmus americana* L.). Wettable powder formulations of benomyl (B), captan (C) and thiabendazole (T) were incorporated in the soil at 500 and 2,000 ppm, and difolatan-4 flowable (D) was applied as a drench at 100 and 500 ppm. Each of the 8 trees per treatment was artificially inoculated in the bole 24 days after fungicide application with about 1.8×10^6 spores of *Ceratostoma ulmi*, the causal organism of Dutch elm disease. Slight phytotoxicity was observed in only 3 trees treated with D at 500 ppm. Foliar wilt symptom of the disease were clearly evident 2 weeks after inoculation, and observations were recorded at monthly intervals until fall dormancy. Final evaluations in September revealed that C and T treatments at the higher level reduce symptom expression by about 50%, and those of B and D by approximately 30%. All higher fungicide levels were better therapeutically than lower concentrations. These results demonstrate the potentiality of Dutch elm disease control by soil-applied fungicides.

CONDUCTOMETRIC AND POTENTIOMETRIC TITRATION OF EXCHANGEABLE ALUMINUM. C. I. Rich. Dept. of Agronomy, Va. Polytechnic Inst., Blacksburg, Va. 24061.

Conductometric and potentiometric titrations of an AlCl₃ solution and AlCl₃-treated Dowex-50, trioctahedral vermiculite, and two montmorillonites were compared with the Al and acidity present in solution or removed from the exchangers with neutral chloride salts. The end points of potentiometric titrations of AlCl₃ or AlCl₃-treated exchangers in neutral salt solution were lowered by these salts and adsorption of partially neutralized hydroxy-Al groups on the exchangers. Titrations of solutions to pH 8.0 gave better estimates of the acidity present than did inflection points. Hydrolysis of Al on the exchanger during exchange may produce H⁺ ions not originally present. Conductometric titrations with Na₂B₄O₇ and NaOH were confounded by incomplete exchange and reaction with Al. The formation of aluminate in the titrations with NaOH and Ba(OH)₂ decreased the conductivity and caused "high" results. It is proposed that conductometric titrations should be continued until the change in conductivity with added base approaches that of a blank. A method for correcting for aluminate formation is proposed. (Aided by S-60 Regional Research Fund, Hatch Act.)

SOYBEAN INSECT CONTROL IN TIDEWATER VIRGINIA BY SOIL-APPLIED SYSTEMIC AND FOLIAR APPLICATIONS. J. C. Smith. Tidewater Research Station, V.P.I., Holland, Va. 23391

The soil-applied systemic insecticides, carbofuran, phorate, and aprocarb, significantly reduced Mexican bean beetle populations in split application tests. Carbofuran at 1.0 and 2.0 lb active/acre and Dasanid® at 2.0 lb active/acre were very effective as layby applications. In a split application test, corn earworm populations were significantly higher in Dasanid® and Temi® treated plots than in untreated controls. Green cloverworm and looper populations were significantly reduced by split applications of carbofuran and disulfoton.

Single applications of foliar sprays reduced high populations of corn earworms, green cloverworms, and loopers, and a moderate infestation of stinkbugs. Azodrin® and carbaryl were particularly effective against corn earworms. All treatments except dimethoate significantly reduced green cloverworms and loopers. Stinkbugs were significantly reduced by all treatments for two weeks, but were increasing populations 41 days after treatment.

Significant yield increases (5% level of probability) did not result from either soil-applied or foliar treatments, although Azodrin and carbaryl were particularly effective in reducing pods damaged by the corn earworm.

SOME DISEASES OBSERVED ON SHADE AND ORNAMENTAL TREES IN VIRGINIA DURING 1968 AND 1969. R. J. Stipes. Dept. Plant Pathology and Physiology, Va. Polytech. Inst., Blacksburg, Va. 24061.

Approximately 611 entries of diseased tree specimens were received and diagnosed in the V.P.I. plant disease clinical laboratory during 1968 and 1969. Although 87 counties submitted specimens during this biennium, the greatest number of samples came from the city of Arlington and from the counties of Montgomery, Henrico, Fairfax, Augusta, Roanoke, Rockbridge, Franklin and Rockingham. Among maple species, *Verticillium* wilt was the most common parasitic disease followed by anthracnose and other leafspots (tar-spots, Bull's-eye spot). Scorch, caused by dry weather, was the most prevalent non-parasitic disease. Among elms, Dutch elm disease of American and winged elms, *Verticillium* wilt, wetwood, viral mosaics and native elm wilt (dieback) were observed. *Verticillium* wilt, powdery mildew and anthracnose were diagnosed on hickory. *Fusarium* wilt of "mimosa" was common. Oak species were affected by anthracnose, leaf blisters and scorch. Endothia canker was found on live oak. Other diseases noted were rust of hemlock, *Verticillium* wilt and *Botryosphaeria* canker of redbud, anthracnose of sycamore, crown gall of willow and powdery mildew of poplar and sycamore. Numerous injuries from chemicals and building construction were observed, as well as many macro- and micronutrient deficiencies. Several undescribed or unknown problems were noted.

HIGH LYSINE CORN SUPPLEMENTED WITH PEANUT MEAL FOR SWINE RATIONS. H. R. Thomas and E. T. Kornegay. Tidewater Research Station, Holland, Va. 23391 and Va. Polytechnic Institute, Blacksburg, Va. 24061

Fifty-six pigs were randomly assigned by weight to four feed treatments replicated twice. The average initial weight of the pigs was 45.6 and 36.1 pounds for replicate one and two, respectively. Two feed treatments were formulated using high lysine corn and two were formulated using normal corn. One treatment containing high lysine corn and one containing normal corn were fortified with 0.4% synthetic lysine (50%). Peanut meal (45%) was used as the protein supplement in each treatment. All treatments were calculated to contain 16% crude protein.

There was a significant response to synthetic lysine supplementation in both the high lysine and the normal corn treatments as shown by average daily gain, feed intake and feed efficiency data. Average daily gain was greatest in the pigs fed the high lysine corn-peanut meal rations plus 0.4% synthetic lysine (50%).

There was a positive relationship between average daily gain and lysine content of the rations with the greatest gain obtained from pigs fed the rations containing the highest level of lysine.

Section of Astronomy, Mathematics, and Physics

Forty-eighth Annual Meeting of The Virginia Academy of Science
May 6-8, 1970, Richmond, Virginia

ELASTIC PROTON-ALPHA SCATTERING ANALYSES. R. A. Arndt*, L. D. Roper, R. L. Shortwell^f. Dept. of Physics, Va. Polytechnic Inst., Blacksburg, Va. 24061

An energy-dependent phase shift analysis from 0-23 MeV has been performed on all existing p-a elastic scattering data. We have obtained a reasonable solution to the majority of the data, but large inconsistencies in the data have been found. We removed the inconsistent data and attempted to refit the remaining data. Our solution did not change.

Input parameters for our fit were obtained from reported single energy analyses plus additional single energy fits we performed using recent Sacay data just below the deuteron threshold (23.04 MeV).

We feel our solution gives reliable phases up through D waves with the exception of the energy range 0-2 MeV. We have been unable to fit the most recent (1949) differential cross section data in this region. (Supported by a grant from National Science Foundation).

STRESSES OF HEXAGONAL DISLOCATION NETWORKS. M. N. Bassim* and D. Kuhlmann-Wilsdorf. Dept. of Physics and Dept. of Materials Science, Univ. of Va., Charlottesville, Va. 22903

The stress distribution about a hexagonal array of screw dislocations was obtained using digital computations. As must be expected, the stress components σ_{rr} and τ_{rz} exhibit a sixfold symmetry. Figures showing the distribution of the stresses were obtained by using symbols of different darkness and overlaid symbols in the printout of the line printer of the B5500 computer, correlated with the coordinate system used, one of the major axes, i.e. $\theta = 0^\circ$, chosen to be parallel to the lines. The computation is of importance in connection with stresses due to dislocation boundaries as are frequently observed in workhardened metals. Discussions with Mr. J. T. Moore and Mr. J. Ingram, Dept. of Physics, University of Virginia, are gratefully acknowledged. (Supported by AEC Contract No. AT-(40-1)-3108)

CONSTANCY OF INERTIAL MASS IN A CENTRIFUGAL FIELD. J. W. Beams, Department of Physics, University of Virginia, Charlottesville, Virginia 22901

The variation in the inertial mass of platinum with respect to that of magnesium produced by a centrifugal field of $1.5 \times 10^3 g$ was found to be less than the experimental uncertainty of 4 parts in 10^4 or 3 parts in 10^{10} per g. The theoretical significance of this null result will be discussed. (Supported in part by Army Office of Research, Durham, North Carolina.)

A PHYSICAL MODEL OF NERVE RECTIFICATION ASSUMING A DOUBLE-DIPOLE-LAYER. James D. Bond^a and L. David Reper. Dept. of Physics, Va. Polytechnic Inst., Blacksburg, Va. 24061

Following suggestions by Wei that the stimulation and conduction properties of nerve cells are largely dependent on the dipole layers at the membrane surfaces, we have performed electrodiffusion calculations based upon a double dipole-layer membrane model. From these calculations we have been able to obtain quantitative fits to the recent potassium iso-osmotic rectification curves of Gilbert and Ehrenstein and to earlier rectification curves of Hodgkin, Huxley, and Katz for a squid giant axon in a normal environment.

PION NUCLEUS SCATTERING. L.A. Charlton^a and J.M. Eisenberg, Dept. of Physics, Univ. of Va., Charlottesville, Va. 22903

Calculations have been done to predict the differential cross section for pion elastic scattering from ${}^4\text{He}$ and ${}^{160}\text{O}$ with pion energies near that of the 3,3 resonance. A multiple-scattering formalism was employed which gives the pion-nucleus scattering operator as a sum over pion-nucleon scattering operators. Absorption and reemission of the pion, which is indistinguishable from the elastic process, was also included to lowest order in the absorption Hamiltonian. Terms in the multiple-scattering expansion were evaluated to apparent convergence for ${}^4\text{He}$ and through second order for ${}^{160}\text{O}$. The results give reasonable agreement with the limited experimental data available. (Work supported in part by NSF).

SOLID-LIQUID PHASE CHANGE IN A DYNAMIC MODEL. J.I. Bennetch, C. R. Powers, G. H. Gilmer, Washington and Lee University, Lexington, Virginia 24450

Pressure measurements have been made on a system^b of approximately 4,000 particles using a gauge with an electronic averaging circuit. A sudden change in slope of the pressure versus density relation occurs as the system develops a uniform hexagonal order. This suggests a second order transition between the "fluid" and "solid" phases. At low "temperature" the density derivative of the pressure approaches zero just below the region of slope change. This may indicate a first order phase transition for a hard disk system which our model should approximate under these conditions. Our pressure measurements are in close agreement with the Monte Carlo calculations in the fluid region.

^bJ. W. Rice, J. I. Bennetch, G. H. Gilmer, Virginia Journal of Science 19, 173 (1968)

DYNAMICS OF FLUX FLOW IN SUPERCONDUCTING THIN FILMS. J.D. Byrd^a and Bascom S. Deaver, Jr. Phys. Dept., Univ. of Va., Charlottesville, Va. 22903.

A magnetic field incident perpendicular to the surface of a thin superconducting film penetrates the film as an array of discrete quantized flux lines leaving most of the film in the superconducting state. We are studying the interaction between these flux lines as they move under the influence of various forces. Using a wide primary film crossed by two narrow superimposed secondary films we observe the voltages in the thin films as flux is forced to move through the array by a dc current in the primary. By measuring the ac voltage in one secondary when an ac current is flowed in the other we have observed a delay time for the propagation of the signal. We discuss interpretations of our results in terms of flux flow. (Research supported by National Science Foundation).

SAFETY CONSIDERATIONS FOR SOLAR GAZING. Alex M. Clarke, Dept. of Biophysics, Med. Coll. of Va., Richmond, Va. 23219

The thermal insult to the human retina is calculated for direct observation of the sun for several cases of interest, and compared with calculations on data taken with an artificial source. The results suggest that the injury sustained by many persons who have engaged in solar gazing must be due to either dilation of the pupil caused by a neural phenomenon or destructive light adaptation, as coagulation would not occur except under anomalous conditions. An inexpensive filter for direct viewing is suggested.

This research was supported by contracts with the U. S. Army Medical Research and Development Command, Office of the Surgeon General, and the Defense Atomic Support Agency, Department of Defense, Washington, D. C.

FIRST PRINCIPLES MONTE CARLO CALCULATION OF HARD SPHERE SYSTEM'S PARTITION FUNCTION, R. L. Coldwell* Washington and Lee University, Lexington, Virginia 24450; Introduced by Edward F. Turner, Jr.

A lattice, which in principle could be arbitrarily small with respect to the spheres, is placed over the system and the variables, r_1, \dots, r_N , are restricted to the lattice points. A technique has been devised for choosing r_1, \dots, r_N randomly from the set of non-overlapping possibilities, and for calculating the probability ab initio of having made such a choice, so that $Z(N,V) = N! \prod_{i=1}^N p_i(N,V)/N!$ The calculations have been carried out for a two dimensional system with an average of four lattice points per particle and the partition function found for densities from 0 to close-packed for systems of 36 and 324 possible particles and for the squares from 9 to 529 for densities to .6 with such similar results that we feel we have an expression for the Z of the infinite system with this lattice. The pressure calculated from this partition function indicates a phase change for densities between .64 and .82, which has probably been greatly enhanced by the imposed lattice structure. (Supported by National Science Foundation, COSIP Grant No. GY-5336)

CHARGED PARTICLE EMISSION FOLLOWING PION CAPTURE IN NUCLEI. L. Coulson*, R.C. Minehart, and K. Zlick. Dept. of Physics, Univ. of Va., Charlottesville, Va. 22903

A beam of negative pions from the 600 MeV synchrocyclotron at the Space Radiation Effects Laboratory of the NASA in Newport News, Virginia was stopped in thin targets made of ^{7}Li , ^{12}C , and ^{27}Al . The charged particles emitted following the capture of a pion were identified by radius of curvature in a magnetic spectrometer and by range in a 28 gap range chamber. We have measured the energy spectra of the hydrogen isotopes emitted as well as the branching ratios for their production for each target. For charged particles with energies above 20 MeV we observed approximately equal numbers of protons, deuterons, and tritons for the ^{7}Li target. From ^{12}C there were 44% protons, 41% deuterons, and 15% tritons, while for ^{27}Al we found 71% protons, 32% deuterons, and 7% tritons.

INFRARED STUDIES OF BERYLLIUM AS AN IMPURITY IN SINGLE-CRYSTAL SILICON. R. K. Crouch, J. B. Robertson*, NASA, Langley Research Center, Hampton, Va. 23365, and T. E. Gilmer, Jr., Physics Department, Va. Polytechnic Institute, Blacksburg, Va. 24061.

Beryllium has been introduced into silicon by thermal diffusion at 1300°C . Electrical and optical measurements show the resulting silicon to be p-type with neutral acceptor levels 191 meV and 145 meV above the valence band. A strong vibrational absorption associated with the beryllium is centered at a frequency of 500 cm^{-1} . The ratio of the absorption coefficient of the peaks for the Set I (191 meV) series of lines to the Set II (145 meV) series of lines can be verified up and down by quenching or annealing but has a minimum value of about .5. The quenching and annealing studies also suggest the 500 cm^{-1} absorption with the Set I impurity site and indicate that Set I is a simpler defect configuration than Set II.

Studies of the interaction of the beryllium impurity with other impurities in silicon indicate that beryllium forms a neutral complex with oxygen. When beryllium is introduced into oxygen-rich silicon, the 9μ absorption band characteristic of interstitial oxygen completely disappears. Even after anneals which remove all the optically active beryllium the 9μ band is never very strong. Beryllium forms optically active centers with lithium which is introduced into the silicon. The lithium complexes with both the Set I and Set II beryllium to form two new acceptor centers at approximately 106 meV and 82 meV.

NUCLEAR STRUCTURE OF ZIRCONIUM ISOTOPES FROM HIGH ENERGY ELECTRON SCATTERING. L. A. Fajardo*, J. R. Flencas*, and W. P. Trower. Dept. of Physics, Va. Polytechnic Inst., Blacksburg, Va. 24061, 1 Sick*. High Energy Physics Lab., Stanford Univ.,†, Stanford, Calif. 94305

We have scattered electrons with incident energy of 300 Mev produced by the Stanford Mark III linear accelerator off four zirconium isotopes ($A = 90, 91, 92, 94$). We extracted elastic and inelastic cross sections from the measured spectra. For elastic scattering a phase shift analysis to a three parameter Fermi shape yielded the nuclear charge distribution. The electro-excited inelastic levels will be discussed. Our results are presented with particular emphasis on isotopic effects.

MODEL ATMOSPHERES FOR $\lambda 4670$ STARS. R. J. Doyle* and S.S. Kumar, Department of Astronomy, University of Virginia, Charlottesville, Virginia 22903.

The $\lambda 4670$ stars are degenerate stars with no hydrogen lines and no carbon lines in their spectra. They do have broad shallow bands which have been identified with the C_2 Swan bands. A program for hydrogen-deficient model atmosphere has been developed with an equation of state that considers the formation of $\text{Cl}, \text{CII}, \text{C}', \text{C}_2, \text{C}_2\text{C}_2, \text{CH}_2$, and singly ionized metals. The C_2 molecular band opacity is approximated using a smeared-line model: eighty-eight frequency points are used to cover the 7 strongest Swan bands.

A number of radiative line-blanketed models have been computed with effective temperatures from 9250 to 5500°K with surface gravities ranging from 10^7 to 10^9 cm/sec^2 . The chemical composition of these stars is predominantly helium, rich in carbon and extremely hydrogen deficient. The corresponding models with convective flux are now being computed. For these convective models, the C_2 bands are weakened due to the rising of the temperature in the shallower depths. A possible model for W 219 ($B-V = .3$, $U-B = -.52$) will have an effective temperature of 7750°K with He/C of the order of 10^4 , and H/C of the order of 10^{-2} . This model shows agreement in band intensity, color and absence of C and H lines with the observed star. This work has been supported in part by the Office of Naval Research of the Department of the Navy.

PULSED NMR STUDY OF TEFLON. Thomas R. Flory* and Alme S. DeReggi* (Sponsored by John W. Stewart), Univ. of Va., Charlottesville, Va. 22903

We have studied the spin-lattice relaxation of the ^{19}F nuclei in PTFE over a broad range of temperature with special interest in the region of the 190°C transition where the NMR line width suggests the onset of rotational motion transverse to the chain axis. The spin-lattice relaxation data is well explained by postulating the existence of two types of nuclei distinguished by different fluctuating environments, i.e. the recovery of z -magnetization has the amplitude $A(t)$ given by

$$A(t) = A_a [1 - \exp(-\frac{t}{T_{1a}})] A_c [1 - \exp(-\frac{t}{T_{1c}})].$$

The amplitudes A_a and A_c are interpreted as the relative number of nuclei which reside in the amorphous and crystalline parts of the sample, and hence give measurement of the degree of crystallinity.

The relaxation times T_{1a} and T_{1c} have separate temperature dependences, which will be discussed in the light of current ideas about the dynamics of the polymer. (Supported in part by the National Science Foundation and the Atomic Energy Commission)

*Supported in part by a grant from the Petroleum Research Fund of the American Chemical Society.

†Supported in part by the U.S. Office of Naval Research Contract (Nonr 225(67)).

EXPERIMENTAL EVIDENCE FOR A MIXED QUANTIZED FLUX STATE IN SUPERCONDUCTING CYLINDERS. William L. Goodman^a and Bascom S. Deaver, Jr. Phys. Dept., Univ. of Va., Charlottesville, Va. 22903.

Detailed measurements have been made of the magnetic flux trapped in hollow superconducting cylinders as a function of the applied magnetic field in which the cylinder was cooled below the transition temperature. We find that for most values of the applied field the entire cylinder is in the same quantized flux state trapping an integral multiple of $hc/2e \pm 1\%$. For some applied fields we have evidence that the cylinder exists in a mixed state with bands along the length in states differing by one flux quantum. This state can be pictured as a quantized flux line weaving in and out of the wall of the cylinder and being pinned there. (Research supported by National Science Foundation).

RADIATIVE PION ABSORPTION IN NUCLEI. Reed Guy^a and J.M. Eisenberg, Department of Physics, Univ. of Va., Charlottesville, Va. 22903.

The absorption into the nucleus of a bound negative pion ordinarily proceeds through a reaction in which two nucleons are ejected. A small percentage of the time in complex nuclei, however, a high-energy photon is emitted; this is the process known as radiative pion absorption. Early study of this reaction was concerned with obtaining a suitable operator to describe the absorption and with a determination of the role that various collective nuclear states play in the process. In the case of light nuclei such as ^{16}O it was predicted that the radiative absorption would preferentially excite spin-isospin states in the final nucleus that are isobaric analogs of states in the giant resonance region of the initial nucleus. We have here considered radiative pion absorption in heavier nuclei with two objectives in mind: a determination of the distribution of strength for the radiative absorption among various analog levels and a consideration of the validity in heavy nuclei of the interaction operator previously used for light nuclei. Results, including estimates of correction terms, are presented for ^{90}Zr . (Work supported in part by NSF).

NUCLEAR POLARIZATION IN MESIC ATOMS. P.K. Haff^a and J.M. Eisenberg, Department of Physics, Univ. of Va., Charlottesville, Va. 22901.

In muonic atoms the electromagnetic interaction can induce a mixing of nuclear states. This nuclear polarization may also be expected to occur in pionic and kaonic atoms by means of the strong interaction. Perturbation theory using hydrogen-like wave functions is, especially for s-waves, not satisfactory due to wave function distortion; thus we develop a modified perturbation formalism to remedy this. Using suitable forms for the meson-nucleon interactions, we study the admixture of nuclear excitations in the meson-nucleus system as functions of nuclear charge and of the mesic principal quantum number.

The relevant matrix elements for both pions and kaons are in all cases studied sufficiently small to ensure that, contrary to the case of muonic atoms, there exists no general class of nuclei in which nuclear polarization from the strong interaction is important. There may be a number of special cases where the nuclear and mesic energies are "accidentally" of such a magnitude as to produce a very small energy denominator and hence large polarization. (Work supported in part by NSF).

BIOPHYSICAL MAGNETOMETER-GRADIOMETER. Z. V. Harvalik, U. S. Army Advanced Materiel Concepts Agency, Alexandria, Va. 22314

The human body seems to be able to detect minute magnetic field gradient changes. If an interaction of a magnetic field with the human body occurs a slight twist of the forearms are observed and can be amplified by a simple mechanical device. The sensitivity of man to magnetic fields can be determined by exposing subjects to magnetic fields produced by electric currents (AC or DC) of varying intensities passing through damp ground. The lower the intensity of the current, thus of the magnetic field, to produce reaction of the subject the greater is his sensitivity to magnetic field changes. A reaction is observed only when negative electrode is at the left (heart) side of the subject. About 80% of the subjects tested show a pronounced sensitivity toward magnetic field changes. Some applications of this bio-physical phenomenon will be discussed as well as its possible mechanism.

MAGNETIC DENSIMETER FOR USE AT CRYOGENIC TEMPERATURES. W.M. Haynes^a and J.W. Stewart, Dept. of Physics, Univ. of Va., Charlottesville, Va. 22901.

We have extended principles of magnetic support developed by Beams and his coworkers¹ to construct a densimeter for cryogenic fluids under pressure. The position of a small ceramic magnet immersed in the fluid under study is detected electronically. Most of the buoy's weight is sustained by a support coil carrying a fixed current I_s regulated to 1 part in 10^6 by a precision power supply.² Two series control coils equidistant above and below the buoy carry the variable control current I_c . Since the current is opposite in these two coils, they provide only a magnetic field gradient dH/dz at the location of the buoy. The magnetic force on the buoy (of magnetic moment M_b) is $F = M_b dH/dz$. It is found that M_b is independent³ of I_c over the latter's range of variability. Thus $F = AI_c + BI_s$ where A and B are constants (at a given temperature).⁴ The densimeter can be calibrated absolutely by supporting in vacuum the buoy of known mass using two values of I_c and determining A and B . This must be done at each temperature. The largest uncertainty in the measured values of fluid densities arises from the volume of the buoy; with improvement the method shows promise of surpassing presently available accuracies. (Work supported by the National Science Foundation.)

¹J.W. Beams, A.M. Clarke, Rev.Sci.Instr. 33 750 (1962).

QUANTIZED FLUX STATES OF CONCENTRIC SUPERCONDUCTING CYLINDERS. Hugh L. Henry^a and Bascom S. Deaver, Jr. Phys. Dept., Univ. of Va., Charlottesville, Va. 22903.

Fluxoid quantization in a multiply-connected superconductor arises from the requirement of single-valuedness of the associated superelectron wave function. As a result, the lowest energy state and the equilibrium magnetization of a superconducting hollow cylinder in a magnetic field are periodic functions of the flux linking the cylinder, with period $hc/2e$. We have studied the problem of two concentric superconducting cylinders in a magnetic field. A calculation of the free energy of such a system was made using the macroscopic energy density equation, $f = H^2/8\pi$, applying as a constraint the condition of fluxoid quantization at all times in each cylinder. The equilibrium magnetization was calculated from the thermodynamic relation, $M = df/dH$. The results correlate extremely well with our experimental data for the equilibrium magnetization. (Research supported by National Science Foundation)

QUASI-ELASTIC ELECTRON SCATTERING. R. D. Kephart*, J. R. Ficenec, and W. P. Trower. Dept. of Physics, Va. Polytechnic Inst., Blacksburg, Va. 24061; I. Sick* and R. Whitmey*, High Energy Physics Lab., Stanford Univ., Stanford, Calif. 94305

We have measured cross-sections for quasi-elastic scattering of electrons from several nuclei: Li, C, Mg, Ca, Ni, Y, Sn, Ta, and Pb. In the processes investigated the single nucleon was injected into the continuum (e, ep) or (e, en). We, however, measure only the scattered electron momentum spectra. To these data we apply radiative corrections and compare them with theoretical cross sections calculated by considering the nucleus to be an ideal Fermi gas. From the width of the quasi-elastic peak interpreted in this way we infer the distribution of momenta of nucleons in the nucleus. The atomic number dependence of the average nucleon momenta is reported here.

*Supported in part by a grant from the Petroleum Research Fund of the American Chemical Society.

†Supported in part by the U.S. Office of Naval Research Contract (Nonr) 225(67).

DISCOVERY OF THE PHOTOMAGNETIC EFFECT. Siegfried S. Meyers. Dept. of Physics, Madison College, Harrisonburg, Va. 22801.

When white light was concentrated upon the entire surface of a semiconductor disc of P-N silicon which was suspended by a silk thread between the poles of a powerful alnico horseshoe magnet, no motion was observed. When the silicon disc was replaced by a sandwich consisting of a thin P-layer on an N-type silicon base exposure of the P-type silicon surface to the light again caused no motion. But, when the opposite surfaces of the disc were short-circuited at the point of suspension with a small drop of solder, the disc vigorously rotated toward an intense pinpoint of white light directed at the edge adjacent to the magnet's South pole and oriented itself in a plane perpendicular to the plane of the magnetic field. When the magnet's poles were reversed the disc's direction of rotation was observed to reverse. Fleming's rule is confirmed by this observation. Since the P-type silicon surface rotated to face the magnet's North-pole the motion was concluded to be caused by PHOTO-INDUCTION of a South-pole on that surface; with a corresponding North-pole Photo-induced on the opposite N-type surface. The incident light upon the P-N junction's edge established a diamagnetic condition. Silicon, by itself, is not diamagnetic. In diamagnetism there are no permanent magnetic dipoles in the material; but, a magnetic moment may be induced by an external field. In this experiment the white light furnished the external magnetic field resulting in the observed PHOTOMAGNETIC EFFECT.

DISLOCATION INTERACTION ENERGIES IN PILE-UPS. Jon T. Moore* and D. Kuhmann-Wilsdorf. Dept. of Physics and Dept. of Materials Science, Univ. of Va., Charlottesville, Va. 22903

The energy of interaction for dislocation pile-ups has been numerically calculated using the known equilibrium positions of the dislocations in the pile-up, for up to fifty dislocations in the pile-up. An analytically determined upper bound was also given for the interaction energy as the number of dislocations becomes infinite.

The results of these calculations permit one to estimate the fraction of energy stored as dislocation interaction energy in stage II, assuming that the dislocations are arranged in pile-ups. (Supported by AEC Contract AT-(40-1)-3108)

GAMMA RAYS FROM C^{11} AND B^{11} FROM π^- SCATTERING ON C^{12} . B. J. Lieb*, H. O. Funsten, Dept. of Physics, College of William and Mary, Williamsburg, Va. 23185, and W. F. Lankford, Dept. of Physics, George Mason College, Fairfax, Va. Nuclear γ -rays from two levels in C^{11} and B^{11} due to bombardment of C^{12} by 365-Mev/c and 435-Mev/c π^- beams have been measured. The γ -rays were detected by a 5-in. NaI crystal in coincidence with a charged particle event in 1 of 4 directional counter arrays surrounding the target. Preliminary results indicate that the ratio for γ -ray yields from the first excited states of C^{11} and B^{11} by π^- scattering at 365 Mev/c is $1.3 \pm .4$. A similar ratio has been found for excitation to the third excited states of C^{11} and B^{11} . γ -rays from the second excited state to the ground state were obscured by 4.44 Mev radiation from inelastic π^- scattering on C^{12} . Direct reaction theory using the free pion-nucleon scattering at the 3-3 resonance would predict that the above ratio would be 9, if the states were populated mainly by π^-N knockout. The possibility of overlapping γ -rays from other nuclei affecting this ratio is currently being investigated.

MOMENTUM SPECTRA OF CHARGED PIONS IN $\bar{p}n$ ANNIHILATIONS AT 3.5 GEV/C. G. E. Moore*, W. M. Sample*, and M. A. Ijaz*. Dept. of Physics, Va. Polytechnic Inst., Blacksburg, Virginia 24061

We have analyzed 50,000 pictures for 3 prong events and 15,000 pictures for 5 prong events from a bubble chamber film exposed to 3.5 Gev/c antiproton beam in a 30 inch MURA, deuterium filled chamber. The momentum distribution of the reactions with three charged pions and either n^0 or n^0 present shows marked deviation from the phase-space prediction. The momentum distribution of the reaction with five charged pions and either n^0 or n^0 present is in better agreement with the phase-space prediction. Transverse momentum distributions of the pions in the above reactions have been analyzed in terms of the Hagedorn model. The temperature of interaction region is 180 Mev for the 3 prong events and 135 Mev for the 5 prong events. The longitudinal momentum spectrum has been analyzed in terms of the two temperature model and agreement is fair.

POLARIZATION ANALYZING POWER OF A HIGHLY EFFICIENT LIQUID HELIUM NEUTRON POLARIMETER. George R. Neil*, Sch. of Engineering and Applied Sciences, and S. T. Thornton*, Dept. of Physics, Univ. of Va., Charlottesville, Virginia 22903.

A high counting rate liquid helium neutron polarimeter has been developed at the University of Virginia to measure neutron polarizations resulting from nuclear reactions. The 5.5 MV Van de Graaff accelerator is used to initiate the nuclear reactions and neutron energies are determined by the time-of-flight method. The polarizations are determined by scattering the neutrons from a 2" by 5" cylindrical liquid helium cell and by subsequent detection by left and right detectors on either side of the cell. Large volume plastic scintillators mounted on photomultiplier tubes are used for the side detectors and another photomultiplier tube detects recoil helium scintillations.

Because of the large densities and solid angles, significant corrections for finite geometry and multiple scattering effects need to be calculated. Two independent computer programs have been used to adequately determine these effects. In addition, wall scattering, shielding in-scattering, electronic and other effects have been studied by both experimental and theoretical methods.

Preliminary measurements have been made in various reactions to compare with previously published results.

(Supported in part by the National Science Foundation).

SPECTROSCOPY USING SUPERCONDUCTING POINT-CONTACTS. Marcello Puma* and Bascom S. Deaver, Jr. Phys. Dept., Univ. of Va., Charlottesville, Va. 22903.

When a sufficiently weak point-contact between two superconductors is biased at a voltage V there are oscillating currents in the point of the Josephson frequency v given by $hv = 2eV$. A resonant absorber coupled to the point-contact produces a characteristic step-like feature in the dc $I-V$ characteristic at the voltage for which the Josephson frequency matches the absorption frequency. We discuss the possibility of using this property for a kind of microwave spectroscopy by coating the point contact with a sample material and interpreting the structure produced in the $I-V$ curve. Our data shows many features that can be understood and many that have not yet been interpreted. (Research supported by Office of Naval Research under project themis).

APPARATUS TO MEASURE THE ABSOLUTE REFLECTIVITY FROM 1 TO 6 EV. Robert S. Rea* and Aime S. DeReggi* (Sponsored by John W. Stewart), Univ. of Va., Charlottesville, Va. 22903

A reflectometer to measure the absolute reflectivity for solids will be discussed. The unusual feature of this device is the method of stabilizing the measurements against drifts in lamp intensity and photomultiplier gain while maintaining a high anode current of the photomultiplier. The accuracy of the measurement is typically $\pm 0.05\%$.

Reflectivity measurements of a Cu-Al crystal (aluminum concentration 7.5% by weight) will be presented and discussed.

(Supported by the Atomic Energy Commission)

A PEDAGOGICAL MEASUREMENT OF THE SPEED OF LIGHT. J. E. Shelton and J. F. Lancaster, Dept. of Physics, Old Dominion University, Norfolk, Va. 23508

An accurate measurement was made of the speed of light in air using the method of Foucault. A laser, photodiode, and digital frequency counter were used to obtain a precise measurement of the frequency of rotation of the mirror. A direct measurement of the speed of light in air was attempted using the rotating mirror to chop the light pulses and an oscilloscope to measure the transit time of pulses over a length greater than 100 meters. Preliminary results demonstrate the feasibility of using the rotating mirror as a beam chopper in making such a direct measurement.

AN EXPERIMENT TO DETECT THE MAGNETIC MONPOLE OF THE RUDERMAN MODEL. D. M. Stevens, G. B. Collins†*, J. R. Ficenec‡, and W. F. Trower, Dept. of Physics, Va. Polytechnic Inst., Blacksburg, Va. 24061

A recent interpretation for anomalous cosmic-ray photon showers has been made in terms of properties expected for the production of bound magnetic pole-antipole pairs¹. These photon showers are unique in that no incident charged particles are seen and the photons are confined to a very energetic narrow cone. Further, in these events, there is a large gap comparable to a radiation length which is devoid of γ -ray conversion. We propose here an experiment to measure these peculiar showers from which the existence of the magnetic pole-antipole pairs can be determined.

FAMILY-STYLE VIEWING OF THE MARCH 7, 1970 TOTAL SOLAR ECLIPSE. J.W. Stewart, Dept. of Physics, Univ. of Va., Charlottesville, Va. 22901.

In order to retain flexibility for a last-minute weather dictated move along the path of totality, I with my wife and 10-year old daughter chose Goldsboro, N.C. as our eclipse headquarters. The weather turned out to be excellent in the Virginia and North Carolina sections of the path of totality, but deteriorated rapidly to the south. From Goldsboro we had a superb view unencumbered by heavy equipment.

The most notable single features of this awe-inspiring spectacle aside from the uniquely beautiful solar corona were the brightness of the inner corona and the shadow bands. The corona was generally of the expected symmetrical sunspot maximum type, but it did have two conspicuous streamers.

The shadow bands appeared two minutes before totality, and lasted roughly the same period afterwards. The width of the remaining solar crescent was then less than one minute of arc; and as it narrowed further the bands became more conspicuous and could be seen on the grass as well as on a white sheet and concrete swimming pool deck. They appeared to be a few inches wide and moved southwest to northeast at perhaps 10 feet per second. They were oriented parallel to the solar crescent. I would guess that the bands could have been seen up to forty miles on either side of the path of totality.

†Also of Brookhaven National Laboratory, Upton, New York.
‡M. Ruderman, D. Zwanziger, Phys. Rev. Letters 22, 146 (1969).

INVESTIGATION OF STATES IN Ne^{20} BY THE $\text{F}^{19}(\text{d}, \text{n})\text{Ne}^{20}$ REACTION. R. M. Strange* and R. C. Ritter, Dept. of Physics, Univ. of Va., Charlottesville, Va. 22903.

States in Ne^{20} populated by the $\text{F}^{19}(\text{d}, \text{n})\text{Ne}^{20}$ reaction have been studied by the use of pulsed beam, neutron time-of-flight techniques. A gaseous CF_4 target was used in order to reduce contaminant effects by incorporation of a gas-in, gas-out subtraction procedure. DWBA and Hauser-Feshbach analysis is in progress.

THE MYSTERY OF THE ELECTRON AND THE STRUCTURE OF THE PROTON: A CALCULATION IN ANTICIPATION OF EXPERIMENT.[†]
W. P. Trower, G. Grammer, Jr.[‡], and B. C. Stringfellow^{*}.
Dept. of Physics, Va. Polytechnic Inst., Blacksburg, Va.
24061

Three electromagnetic scattering processes, whose determination experimentally to high precision are of fundamental importance to the understanding of the basic structure of matter are: 1) elastic charged lepton-proton scattering to determine if the electron and muon are equivalent particles, 2) low energy elastic electron-proton scattering to investigate the existence of a proton charge halo, and 3) very high energy elastic electron-proton scattering to determine the granularity, if any, of the proton and to investigate the existence of a central core in the proton. Present quantum electrodynamic calculations are insufficiently accurate to enable meaningful interpretation of experimental results. Here we extend the existing calculations to levels of accuracy which exceed the current capability of measurement. The application of these calculations to the above described experiments is demonstrated.

[†]Work supported in part by a grant from the Research Corp.

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MULTIPLE ORDER-DISORDER TRANSITIONS IN COMPRESSIBLE ISING LATTICES. C. C. Walton*. Dept. of Physics, Univ. of Va., Charlottesville, Va. 22903

Order-disorder phenomena in compressible Ising lattices under variable temperature and pressure conditions are described in the Bragg Williams approximation. Peculiar to the present treatment is the representation of the ordering energy in terms of inter-atomic interaction potentials consisting of two terms with different power dependence on the interatomic distance, r . The dependence of the ordering energy upon r is assumed to be of the form,

$$\epsilon(r) = \epsilon_1(r/r_0)^{\beta_1} + \epsilon_2(r/r_0)^{\beta_2}, \text{ where } r_0 \text{ is}$$

the inter-atomic separation distance of the disordered lattice under zero pressure. The energy dependence of the disordered lattice upon the separation distance is represented by a simple harmonic potential.

It is shown that in certain lattices both a first and second order transition, or two first order transitions will occur as the temperature or pressure is varied in the critical region. (Supported by AEC Contract No. AT-(40-1)-3108)

DEMONSTRATION OF THE AC JOSEPHSON EFFECT IN THE ADVANCED UNDER GRADUATE LABORATORY. John P. Wikswo, Jr.[†], and Bascom S. Deaver, Jr., Phys. Dept., Univ. of Va., Charlottesville, Va. 22903

When a voltage V is maintained between a pair of weakly linked superconductors there is an oscillating current between the superconductors at frequency ν given by the Josephson relation $h\nu = 2 eV$. In addition to being a fundamental property of superconductors, this phenomenon is the basis for the most precise determination of the fine structure constant and is being applied in an amazing variety of superconducting devices; thus it is a particularly appealing topic for inclusion in an undergraduate laboratory.

An adjustable Nb point-contact mounted in a general purpose cryostat designed for a variety of low temperature experiments is being used to study the properties of weakly linked superconductors. The existence of oscillating currents is demonstrated by coupling the point-contact to a tank circuit tuned to 60 MHz and observing the output from the circuit as a function of voltage across the point-contact. In addition the current-voltage characteristic and the effects of magnetic fields and electromagnetic radiation can be observed.

Section of Biology

Forty-eighth Annual Meeting of The Virginia Academy of Science
May 6-8, 1970, Richmond, Virginia

STAINING TECHNIQUES TO FACILITATE IDENTIFICATION OF SIPHONOPHORES OF THE FAMILIES MONOPHYIDAE, DIPHYIDAE AND ABYLIIDAE. John S. Alman and H. G. Marshall, Old Dominion University, Norfolk, Va. 23508.

Due to the near transparent nature of siphonophores in the families Monophyidae, Diphyidae, and Abylidiae, identification without the aid of stain is extremely difficult. An abbreviated technique for staining specimens of these families for identification purposes is described.

Six stains are utilized, methylene blue, carmine (alum lake), crystal violet, safranin O, eosin Y and iodine; two of which are effective singly by adding them to the plankton tow sample.

A technique to save time when staining large numbers of specimens by transferring them en masse from step to step was discussed. Overstaining can be corrected by differ-entiating in an acetic acid-alcohol solution.

All siphonophore specimens were collected during Cruise E-501-68/69 aboard the research vessel EASTWARD, operated by Duke University Marine Laboratory.

THE CHESAPEAKE BAY STUDY AND HYDRAULIC MODEL. CPT. Kenneth L. Beal, U. S. Army Engineer District, P. O. Box 1715, Baltimore, Maryland 21203.

The Chesapeake Bay Study is a comprehensive investigation of water utilization and control of the Chesapeake Bay Basin, including navigation, recreation, economics, water quality, waste treatment, noxious weeds, flood control, fisheries, erosion and water pollution. The study was authorized by Congress in the River and Harbor Act of 1965. An Advisory Group consisting of State and Federal representatives has been organized, and a plan of study has been prepared.

The Chesapeake Bay Study will be the first comprehensive study of the entire Bay system. Comprehensive water resource studies have been made on several Bay tributaries (James River, Potomac River, Patuxent River and Susquehanna River), which will provide valuable background information.

As a tool in this investigation, a hydraulic model is planned, which will encompass the Bay and all its tributaries to the head of tide. This model will reproduce currents, salinities and bathymetry precisely, and will simulate a semidiurnal tidal cycle (12 hours 25 minutes) in $\frac{1}{3}$ minutes. The model will facilitate the study of the biological and physical mechanics of the Bay and provide answers to ques-tions such as: How do water masses of different densities and temperatures mix and disperse? How are sediments trans-ported and deposited?

The model will also be used as a tool by the several re-search institutions located on the Bay for their studies.

GEO MAGNETIC EFFECTS ON A CIRCADIAN DIFFERENCE IN REACTION TIMES IN EARTHWORMS. Miriam F. Bennett and Jan Huguenin. Dept. of Biology, Sweet Briar College, Sweet Briar, Va. 24595

The effect of geomagnetic force on the light-withdrawal reflex of earthworms, *Lumbricus terrestris*, L., was investigated from October through December, 1968. The reactions of worms kept in the earth's magnetic field were timed beginning at 12:00 and 20:00 on each of 63 days; the same was done for worms maintained in a field whose intensity was essentially zero. The worms in the earth's field withdrew from light significantly faster (20%) at night than at mid-day. No difference between the mean reaction times at 12:00 and those of the evening were found for the animals which lived and were tested in the greatly reduced magnetic field. Geo-magnetism does have some effect on the circadian difference in reaction rates in this species. The possible sites and natures of this effect were discussed.

BODY SIZE AND COLD TOLERANCE IN SOME ENDOTHERMS. Charles R. Bleh, Dept. of Biology, Va. Commonwealth Univ., Richmond, Va. 23220

A model is presented to demonstrate that Bergman's eogeographic rule can be considered to be a result of adaptation to low temperature. Data from a study of geographic variation of the bioenergetics of the House Sparrow (*Passer domesticus*) reaffirms Bergman's rule and fits the proposed model.

THE RELATIONSHIP OF FRESH-WATER PROTOZOAN COMMUNITIES TO THE MACARTHUR-WILSON EQUILIBRIUM MODEL. John Cairns, Jr., M. L. Dahlberg, Kenneth L. Dickson, Nancy Smith, and William T. Waller, Dept. of Biology, Va. Polytechnic Inst., Blacksburg, Va. 24061

Two series of 10 artificial substrates each were placed in Douglas Lake, Michigan, and their colonization by species of fresh-water protozoans studied. Identifications were made to species whenever possible at intervals of approximately one week, and rough estimates of density were made as well. Although the aggregations of species colonizing each of the substrates were not identical, the colonization process itself was remarkably similar for the entire series. When the number of species was plotted against time in days, a simple exponential curve adequately described the relationship. Colonization rates and extinction rates were compared with the equilibrium model for island faunas proposed by MacArthur and Wilson. These results suggest that the formation and composition of protozoan communities on artificial substrates are the result of interactions comparable to those proposed by MacArthur and Wilson. (Full paper published in *The American Naturalist*, Vol. 103, 1969, pp. 439-454).

HEPATIC AND OVARIAN GROWTH IN *DIPSOSAURUS DORSALIS*. Ian P. Callard. Dept. of Biology, Col. of William and Mary, Williamsburg, Va. 23185.

In oviparous reptiles and other submammalian vertebrates, ovarian estrogen secretion during follicular maturation is known to be involved in the stimulation of liver growth and synthesis of vitellogenetic proteins. The vitellogenetic proteins are then deposited in the ovary under the influence of other hormones. It is thought that the action of estrogen is a direct one. The results of this study have clearly demonstrated that the presence of the pituitary gland is necessary for estrogen-induced liver hypertrophy. In addition, the work indicates that ovarian growth, induced by an exogenous gonadotropin (PMS) is also dependent upon the pituitary, and that the factor necessary is growth hormone (GH). Since hepatic vitellogenesis and ovarian growth are inseparable processes, the second being dependent upon the first, and both are dependent upon the pituitary, it is suggested that GH is the pituitary factor necessary for estrogen induced liver hypertrophy and therefore, indirectly, ovarian growth. Further, that as ovarian follicles mature, estrogen acts to stimulate vitellogenesis in two ways: 1) By acting upon the liver 2) By enhancing the release of GH from the pituitary gland.

THE ACCUMULATION OF ALANINE IN ISOLATED GILL TISSUE OF *MYA ARENARIA*. W.D. DuPaul^a and K.L. Webb^b. Va. Inst. of Marine Science, Gloucester Point, Va. 23062.

Isolated gill tissue of *Mya arenaria* was incubated in conditions of increased osmotic pressure (31 o/oo salinity) under aerobic and anaerobic conditions. The gill tissue continued to accumulate significant quantities of free alanine during the first 8 hours of incubation. The accumulation of alanine under anaerobic conditions was related to the amount of aspartic acid present in the tissue before incubation and to the apparent inability of the tissue to replace the aspartic acid used in the synthesis of alanine. The high linear correlation coefficients (0.84-0.99) between aspartic acid and alanine under incubation conditions reinforce a proposed relationship between these amino acids involved in isosmotic intracellular regulation.

Gill tissue incubated under anaerobic conditions and no increase in osmotic pressure (18 o/oo salinity) showed marked changes in the concentration of free alanine and aspartic acid. These changes were similar to those that took place under conditions of increased osmotic pressure and may be related to the decrease in tissue water content which occurred under anaerobic conditions.

The accumulation of free alanine in isolated gill tissue of *M. arenaria* is similar to that found in whole animals, thus validating the use of isolated tissues.

RAPID BIOLOGICAL INFORMATION SYSTEMS FOR WATER POLLUTION CONTROL. John Cairns, Jr., Kenneth L. Dickson, Richard E. Sparks, William T. Waller, Dept. of Biology, Va. Polytechnic Institute, Blacksburg, Virginia 24061

Some of the significant processes of the biosphere are acyclical and others cyclical. Cyclical ecological processes involve complex interlocking cause-effect pathways, regenerative circuits, feedback mechanisms and the like. Humanity is dependent upon these complex ecological systems which an expanding population is placing under increasing stress. In order to insure adequate function of ecosystems in waste degradation, oxygen production, etc., we must determine their operational prerequisites and monitor both ecosystem condition and the toxicity of wastes before discharge into an ecosystem. One of the chief obstacles to adequate environmental management of this type is the comparatively enormous amount of time required to generate biological information compared to chemical-physical ecological information. In addition, most biological information is sparsely intermittent rather than continual. We are developing two continually operative "in plant" rapid information systems using fish EKG's, breathing, and movement patterns to assess the toxicological effects of industrial wastes before they enter the receiving stream and have developed one "in-stream" rapid information system that can provide intermittent biological information in hours rather than in the days or weeks usually required. (Full paper in press with the *Journal Water Pollution Control Federation*. Research supported by Manuf. Chem. Assn.).

THE INFLUENCE OF WATER TEMPERATURE AND OTHER ENVIRONMENTAL FACTORS ON THE SPAWNING RUNS OF THE GENUS *ALOSA* IN THE PAMUNKEY RIVER. J. B. Conley*, and J.R. Reed, Virginia Commonwealth University.

Several species of the genus *Alosa* ascend Virginia tidal rivers and their tributaries in the spring in search of suitable spawning areas. Initiation of the spawning runs is generally attributed to increases in water temperature. This study examined the effect of water temperature and other environmental factors on the spawning migrations of *Alosa pseudoharengus*, *A. sapidissima*, and *A. aestivalis* in the Pamunkey River.

Of the three species examined, *A. pseudoharengus* was the earliest spawner, followed by *A. sapidissima* and *A. aestivalis*. The sequence of spawning runs was determined primarily by water temperature and secondarily by such factors as tide, light conditions and wind.

THE RECONCILIATION OF ETHOLOGY AND MORPHOLOGY IN THE EVOLUTIONARY SYSTEMATICS OF KATYDIDS (ORTHOPTERA: TETIGONIIDAE). M.G. Emsley, Dept. of Biology, George Mason College of the Univ. of Va., Fairfax, Va. 22030

The morphology of the stridulatory organ is a useful character in the taxonomy of most sound-producing Orthoptera and is an excellent specific character in *Tettigoniidae*. Evidence is presented to suggest that the behavioral isolation which results from changes in the song pattern of allopatric or allochronic populations may be based on the differentiation of the morphology of the stridulatory organ in accordance with simple mathematical rules.

THE RESEARCH POTENTIAL OF THE NEOTROPICAL MIMETIC BUTTERFLIES OF THE GENUS *Heliconius* (LEPIDOPTERA: NYMPHALIDAE). M.G. Emsley, Dept. of Biology, George Mason College of the Univ. of Va., Fairfax, Va. 22030

Comparison of adult and larval morphology, geographic distribution, pigment biochemistry, behavior and the inheritance of color-patterns has provided a foundation for the study of evolution of *Heliconius* in Central and South America.

Further insight into the origin and significance of mimetic relationships requires the identification of the predators and the investigation of their visual acuity and learning ability; a detailed knowledge of the origin of the toxic substances in distasteful specimens and of the biology and distribution of the food plants; the detection of linkage between the pleiotropic effects of genes controlling adult color-pattern and larval characters; and the functioning of courtship releasers in dissimilar allopatric forms of single species and in specimens from the intervening areas of balanced polymorphism.

SOME OBSERVATIONS ON THE ORIGIN OF MICROTUBULES IN THE AXONS OF THE DEVELOPING HAMSTER OPTIC NERVE. Thomas M. Harris, Dept. of Anatomy, Med. Col. of Va., Richmond, Va. 23219

Microtubules and neurofilaments have been recognized as consistent ultrastructural components of nerve fibers since the work of Palay ('56). Peters and Vaughan ('67) described the possible differentiation of neurofilaments from microtubules in the optic nerves of neonatal mice. I have recently described the process of initial nerve fiber invasion in the embryonic optic stalk of the hamster (Harris '69) and the role of growth cones in this process (Harris '70). This present report deals with certain preliminary observations related to the possible mode of differentiation of microtubules in optic nerve axons in the hamster.

Electron microscopic observation of transverse sections of embryonic optic nerve axons consistently reveal one to four circular profiles, approximately 250-300 Å in diameter that resembles the microtubules described by other workers in various embryonic neural tissue. However, oblique and longitudinal sections of our material reveal that the profiles are of spherical or ovoid vesicles randomly distributed throughout the axon. It is suggested that the microtubules of the neo-natal optic nerve axons may develop by a fusion of the vesicles present in the primary nerve fibers. (Supported by NIH grant HD 1789-04).

RESPONSES TO LOW OXYGEN CONDITIONS IN TWO SPECIES OF THE GASTROPOD *NASSARIUS*. L. J. Kushins^a and C. P. Mangum, Dept. of Biology, Col. of William and Mary, Williamsburg, Va. 23185.

Two species of mud snail, *Nassarius obsoletus* and *N. trivittatus* are common inhabitants of the mudflats along the York River. They have a marked tendency to burrow, making them inhabitants of a truly hypoxic environment. Measurements of oxygen consumption (\dot{Q}_{O_2}) at decreasing P_{O_2} 's starting from air saturation were made on animals before and after 24 hr exposure to anoxic conditions. Comparison of these measurements shows a significant difference between \dot{Q}_{O_2} before and after exposure. The rate of mortality due to anoxia is typically molluscan, i.e. the LD₅₀ is greater than 192 hr.

In most cases where oxygen consumption was measured in vessels larger than 65 ml, the animals depleted the supply of oxygen to a critical level and stopped. A comparison of the critical pressure before and after anoxia shows a significant ($p < .05$) difference. When these animals were immediately placed in air saturated water and measured again, the residual pressure decreased in unexposed animals while it increased in six of eight animals previously exposed to anoxic conditions.

THE ROLE OF ACETYL γ CHAINS IN THE BIOSYNTHESIS OF HUMAN FETAL HEMOGLOBIN. M.D. Garrick, D.M. Rogers^a, J.P. Charlton^a, and L.V. Morris, Dept. of Biology, Univ. of Va., Charlottesville, Va. 22903

A minor fraction (γ_1) equivalent to about 5% of the total protein elutes prior to γ chains when globin chains of a dehemmed hemolysate from umbilical cord blood are separated by chromatography on carboxymethylcellulose in 8M urea according to Clegg, et al. (J. Molec. Biol. 19:91, 1966). γ_1 represents a quarter of the protein of purified hemoglobin F₁. Starch gel electrophoresis in 6M urea, absorption spectra, amino acid compositions, and determinations of ^{3}H -isoleucine incorporation all indicate that the γ_1 chains are very closely related to the γ chains of hemoglobin F. Amino terminal analysis indicates the presence of an acetyl blocking group on the γ_1 chain. In a cord hemolysate labeled acetate from acetyl-coA is not restricted to incorporation only at the aminotermminus of γ_1 . Pulse-chase experiments with labeled amino acids suggest that γ_1 is an intermediate in the biosynthesis of the γ chains. It is tempting to speculate that the blocked aminotermminus of γ_1 is a residuum of an initiator mechanism for eukaryotes.

SEXUALITY IN *DUGESIA DOROTOCEPHALA*. Marie M. Jenkins, Dept. of Biology, Madison Col., Harrisonburg, Va. 22801.

An investigation was made of reproductive activities in three asexual and three sexual races of *Dugesia dorotocephala*. Sexual maturation occurred sporadically and with extreme rarity in the asexual races but was without seasonal correlation. Fission was constant throughout the year and was the only effective means of propagation. In the sexual races cocoon production began when the animals were 4-6 months old and continued during all months of the year for 2-4 years thereafter. Fission occurred occasionally in pre-adult sexual worms but not in those mature enough to mate and deposit cocoons. No alternation of asexual and sexual phases occurred in any race at any time. In sexual animals, cut in two between the mouth and the gonopore, regeneration of sexual organs and deposition of viable cocoons was re-established in head pieces within less than a month and in tail pieces within 4 1/2 months. Animals with 2-6 supernumerary gonopores produced cocoons and living young during an 11-month period of investigation, but did not undergo fission during that time. The theory that supernumerary gonopores constitute morphological evidence of physiological isolation of zooids prior to fission is thus shown to be erroneous. Sexual races studied were collected south of the 35th parallel or close to it; asexual races were all obtained well north of latitude 35. A possible relationship between latitude and the occurrence of sexual and asexual races of the species was discussed. (Aided by a Madison College Research Grant.)

DAILY AND SEASONAL DISTRIBUTION OF ACTIVITY IN CAPTIVE RACCOONS. C. laban, Dept. of Biology, Richard Bland College, Petersburg, Va. 23803

A study was made of the level and distribution of activity by raccoons kept in a simulated natural habitat. Observations on the following categories were made; brother-brother, sister-sister, male-female, and mother-offspring as well as hand-reared versus mother-raised, and captive-born versus live-trapped individuals.

Distribution in time, the duration, and the sequence of occurrence of behavioral activities (motor behavior) were recorded to the nearest 5 second interval throughout the 24-hrs. cycles of observation. Most of the postures and unit sequences of motor behavior could either be coded or expressed in short declarative sentences. The data was subsequently transferred to activity graphs where the original sequence, duration, and the total time spent in any given activity could be scanned quickly as to time-of-day, and in relation to the overall ongoing behavior. The present paper discusses the daily cycle of activity as observed in adult raccoons throughout the four seasons.

REPRODUCTIVE BEHAVIOR OF THE ALFALFA WEEVIL, *HYPERA POSTICA*, AS AFFECTED BY STORAGE CONDITIONS. G. Leonard LeCato, III, and R. L. Pieknowski*, Dept. of Entomology, Va. Polytechnic Inst., Blacksburg, Va. 24061

Field-collected alfalfa weevils exposed to 8 different storage and testing conditions in the laboratory were evaluated for reproductive behavioral responses. Males isolated in petri dishes built up and stored sexual energy, allowing them to exhibit highly aggressive mating behavior toward either sex. Two males stored together mounted each other and lost sexual energy, reducing subsequent matings. A male and a female stored together in a petri dish copulated frequently, and the male lost considerable sexual energy. Males stored together or with females under moderately crowded conditions were less aggressive when tested than non-crowded males. Highly crowded males stored with females showed severely diminished libido during the evaluation period. These observations would indicate that if studies on the alfalfa weevil are to accurately evaluate reproductive behavioral responses, one should be concerned with storage conditions which may either accentuate or diminish sexual behavior to a significant degree.

RENAL PATHOLOGY AND RNA POLYMERASE ACTIVITY IN ISOLATED KIDNEY NUCLEI FROM SYRIAN HAMSTERS CHRONICALLY FED PURIFIED AFLATOXIN B₁ AND IMPLANTED WITH 17_B ESTRADIOL. G. C. Llewellyn, Biology Dept., Va. Commonwealth Univ., Richmond, Va. 23220; W. G. Hansen, Biounucleonics Dept., Purdue Univ.; and W. W. Carlton[†] Veterinary Pathology, Purdue Univ., Lafayette, Ind. 47906

Weanling male hamsters were implanted every five weeks with 30 mg of 17_B estradiol and fed 1 ppm aflatoxin B₁ for periods upto 259 days. Estrogenized animals developed renal carcinomas after 210 days and tumors increased in severity with time. Aflatoxin produced minimal renal involvement including hyperchromatic nuclei and vacuolated cytoplasm after 161 days of exposure. Animals receiving both agents developed kidney tumors with a greater degree of gross pathology than those treated with estrogen. Incorporation of C-14 ATP into RNA by kidney nuclei was recorded as: Estrogen Treatment > Aflatoxin B₁ Treatment > Aflatoxin B₁ and Estrogen Treatment > Control Sham-Operated Animals. (Supported by Purdue Environmental Health Institute)

VARIATIONS IN SOME SERUM CONSTITUENTS OF THE BLUE CRAB, *CALLINECTES SAPIDUS*, RATHBUN. M.P. Lynch, K.L. Webb^a, and W.A. Van Engle, Va. Inst. of Marine Science, Gloucester Point, Va. 23062.

Serum protein(Pr), chloride(Cl), glucose(G) and ninhydrin positive substances(NPS) were determined in samples of blood from the Blue Crab, *Callinectes sapidus*, collected at various locations and times from Va. waters. Monthly mean values from one area (Feb. '69-Mar. '70) show the following ranges: Cl, 31755 mill-equiv./l; Pr, 23-101 mg/ml; NPS, 4-23 micromoles/ml; and G, 12-70 mg/100ml. Seasonal and year class(YC) differences were found in Cl and Pr values. Cl was higher in the late fall and winter and lower in summer. Pr and Cl appear to be lower in 1968 YC than 1967 YC mature females. Mean Pr was lower in males than females in all months in which males were sampled except for July and Aug. '69. No apparent seasonal, YC, or sexual differences have been found as yet between G or NPS values.

Data from samples taken along an estuary (1.3-19.0 o/oo salinity) in Aug. '69 indicate there is a positive relation between environmental salinity and serum Cl. Samples from crabs in different stages of the molt cycle indicate an order of magnitude increase in Pr associated with molting. G and NPS values were variable and have not been correlated with environmental or other physiological variables.

PHOTOPLANKTON IN TROPICAL SURFACE WATERS BETWEEN THE COAST OF ECUADOR AND THE GULF OF PANAMA. H.G. Marshall, Dept. of Biology, Old Dominion University, Norfolk, Va. 23508.

The cold waters of the Peru Coastal Current flow northward along the South American coast to continue westward as part of a great gyre that passes below Cabo Blanco. An oceanic front separates this cold current from the tropical surface waters that usually extend south to the Gulf de Guayaquil. Collections of surface phytoplankton were made north of this front from Guayaquil to the Gulf of Panama aboard the R/V ANTON BRUUN. The phytoplankton was characteristically a warm water flora, predominated by diatoms directly off the coasts, with phycoflagellates (coccolithophores, dinoflagellates) more abundant in pelagic waters. Index species previously noted for the Peru current were not observed in the samples. Comments on the distribution of 53 species were made. The common diatoms included eight *Chaetoceros* spp., four *Nitzschia* spp., and eight *Nitzschialena* spp. *Planktonella sol* was ubiquitous. The silicoflagellates *Disepanthus speculum* and *Dicyospha fimbria* were common in open water samples as were the dominant pelagic phytoplankters, the coccolithophores, *Coccolithus huxleyi*, *Gephyrocapsa oceanica*, and *Cyclococcolithus leptoporus*.

OBSERVATIONS ON THE PELAGIC GASTROPODS FROM THE LESSER ANTILLES. Vincent J. McPhermott and H. G. Marshall, Old Dominion University, Norfolk, Va. 23508.

The pelagic gastropods were studied in 15 net tow samples taken along a 360 mile transect from waters west of the Lesser Antilles. These samples were compared to 18 net tows from the waters northeast of Cuba.

Net tows from the Nicholas and Santaren channels during February 1969 contained 14 species of euthecosomatous pteropods, with no other pelagic gastropods observed. *Spiratella inflata* was the dominant form in total numbers in the surface samples, with two species of the family Caenidae appearing only at the intermediate depths.

Net tows from the surface and sub-surface waters west of the Lesser Antilles, 20-26 January 1970, indicated a decrease in species diversity and in the numbers of pteropods, but an increase in the number of pelagic gastropods. The pteropods were *Spiratella inflata*, *Greesia acicula*, *Greesia virgula*, and *Clio polita*, respectively, in decreasing order of abundance. Seven species of gastropod larvae were observed, with *Architectonicaidae* sp. the most numerous from the samples. The appearance of such large numbers of this species and the other larval forms is apparently due to their origins in the communities of benthic gastropods present in the island complex of the Lesser Antilles. All collections were made during cruises E-51-I 68/69 and E-1C-70 of the research vessel EASTWARD operated by the Duke University Marine Laboratory.

FURTHER OBSERVATIONS ON THE STIMULATORY EFFECTS OF CRAYFISH EYESTALK EXTRACT ON RESPIRATION OF MAMMALIAN TISSUES.

William L. Mengelker and Brian D. Kennedy*, Dept. of Biology, Bridgewater Col., Bridgewater, Va. 22812

Eyesstalk extracts from *Cambarus bartoni* were prepared by homogenization in phosphate buffer, followed by centrifugation at 0°C for 2 hours at 10,000 x g. The effects of this extract on the endogenous respiration of rat liver, brain, and kidney were determined, as well as the effects of the extract on crayfish muscle and digestive gland. All measurements were made utilizing the Warburg technique.

Significant increases in the oxygen uptake of all tissues were observed and a direct relationship between activity rate and the amount of extract added was noted. Concentration of the extract with LYPOGEL resulted in a further increase in rates of activity. In terms of the absorptive qualities of this gel, the active component(s) of the extract has a molecular weight above 24,000. (Aided by a grant from the Virginia Academy of Science)

BIOLOGICAL OXIDATION AND REDUCTION OF MANGANESE IN RAW WATER TRANSMISSION LINES. R. C. Moesner, E. I. Dupont, Inc., Richmond, Va. and A. H. Johnson, Dept. of Biology, Old Dominion University, Norfolk, Va. 23508.

Frequently in late summer and early fall water purification plants in the City of Norfolk experience sudden and periodic increases of manganese in the raw water transmission lines. Most of the manganese arriving at the treatment plant is soluble manganese manganese (Mn^{+2}) which is difficult to remove from the water supply. Much of it passes through the plant where it is oxidized to Mn^{+4} in latter stages of treatment to become the substance of tea-like water occasionally pumped to the consumer. Surveys of reservoir lakes and raw water transmission lines indicated that variations in manganese content of water entering the purification plant were associated with fluctuations in the transmission lines rather than sudden changes of manganese in reservoirs. A pipeline constructed to simulate conditions in raw water transmission lines suggested that manganese surges mentioned above may be due to a geochemical cycle in raw water lines. In this cycle, Mn^{+4} deposits in raw water lines, caused by microbial oxidation of soluble Mn^{+2} in the water supply, could be stripped off by changes in water flow rate. As water travels to the purification plant, a reduced oxygen tension of water in the latter portion of the pipeline would favor biological reduction of suspended Mn^{+4} particles and increase soluble Mn^{+2} in untreated water.

ELECTRICAL ACTIVITY IN THE OLFACTORY SYSTEM OF SOME FRESH WATER TELEOSTS. E. Muller, S. Brady, D. Kimbrough and J. Reed, Dept. of Biology, Virginia Commonwealth University, Richmond, Va. 23220

Behavioral studies have shown that some species of fresh-water teleosts can detect the odor of predatory fish. The purpose of this research was to record and compare patterns of electrical activity in the olfactory systems of fish exposed to odors of predatory and nonpredatory species.

Recordings obtained under the experimental conditions have been influenced by electrical interference, condition of the fish, type of electrodes used and location of the electrodes. A method has been devised which permits identification of many of these factors. With proper refinements this method should produce meaningful data.

AROUSAL STUDIES ON THE FREE-TAILED BAT, TADARIDA BRASILIENSIS CYNOCEPHALA. John F. Pagels, Dept. of Biology, Va. Commonwealth Univ., Richmond, Va. 23220

Tadarida brasiliensis cynocephala (Le Conte) was resident in New Orleans, Louisiana in the winters 1967-1968 and 1968-1969. The bats fed periodically during winter months; however on cold days, the bats were inactive and often torpid. In laboratory studies to determine the effects of cold exposure on the animals ability to rearm to flight temperature, it was determined that the total number of warmups plays an important role in the animal's ability to arouse to flight temperature on subsequent attempts. The effect of warmups on successive evenings was observed to be greater than the effects of prolonged cold exposure. In all arousal experiments, the body weights of animals that rewarmed were greater than the body weights of animals that did not rearm. Also, in all warmup experiments, the total amount of interscapular brown fat and interscapular brown fat as a percentage of body weight were greater in animals that rewarmed than in animals that did not rearm.

DIFFERENTIAL GENE EXPRESSION: PUROMYCIN AS AN INDICATOR OF RATE LIMITING AMINO ACYL tRNA. L.V. Morris and M.D. Garrick, Dept. of Biology, Univ. of Va., Charlottesville, Va. 22903

When o-methylthreonine is used to lower the concentration of ile-tRNA in reticulocytes from newborn humans, the reduction in adaptor concentration leads to a more than additive interaction with puromycin in blocking *in vitro* synthesis of the Y chain. This specific effect on incorporation into fetal hemoglobin demonstrates the utility of comparing two or more proteins with respect to the influence of puromycin on their biosynthesis. A differential response would indicate differences in the availability of amino acyl tRNA for translating their respective mRNA's. Such an approach should be particularly valuable in developmental situations where there is a changing pattern of protein synthesis.

THE EFFECTS OF SALINITY AND DECREASING TEMPERATURE ON POLYP STAGES OF THE JELLYFISH, AURELIA AURITA AND CHRYSACRA QUINQUECIRRHA. Janet Olson* and K. L. Webb*, Va. Inst. of Marine Science, Gloucester Point, Va. 23062

Polyps of *Aurelia aurita* and *Chrysacra quinquecirrha* were subjected to nine salinities from 0-40 o/oo and temperature decreasing at the rate of 5° per week from 25 to 0°C. The effects of salinity and falling temperature on polyp activity, survival, budding, strobilation and stolon formation were determined by weekly observation. Control polyps were held at 25°.

Aurelia control polyps survived and produced buds at 10-40 o/oo. Strobilation occurred spontaneously at 10-40 o/oo, with a maximum average frequency of 2.6%. *Chrysacra* control polyps at 25° survived between 5-40 o/oo and produced stolons at 10-40 o/oo.

Feeding activity and reproduction continued in experimental polyps of both species at 15°. After a week at 10° most activity and reproduction had ceased and the polyps remained in a contracted condition; the same condition prevailed at 5°. Both species survived well for one week at 0° between 15-35 o/oo; however, all the *Aurelia* polyps died during a second week at 0°.

INFLUENCE OF DOGS ON DEER IN AREAS OF VIRGINIA. Matthew C. Perry, Va. Polytechnic Inst., Blacksburg, Va. 24061

Three study areas and five techniques were used in this study of movement and activities of dogs and influence of dogs on deer. Radio-tracking with telemetry equipment was ineffective due to infrequent and unpredictable movement of dogs. The percentage of licensed dogs estimated from surveys of rural inhabitants was suggested to be inversely related to the number of residents under a dog warden's responsibility. Activity indices determined from sand plot track counts for dogs were insignificantly different for three study areas and for the three seasons. Dogs appeared to be most active in morning between 7:00 a.m. and 10:00 a.m. Activity and movement data from this study were compared with questionnaire responses from game wardens and biologists and data from other sources. Six dogs were trapped at Big Levels during the fall. Two were instrumented but tracking was ineffective. Approximately 70 percent of the dogs trapped and tracked during this study were hounds. Data concerning age and condition of deer killed by dogs in Virginia were scarce.

Free-running dogs may present less of a problem in eastern Virginia than in western Virginia due to physiography of region. Dogs are probably a serious mortality factor in deer stocking programs or in areas of low deer number. Enforcing dog laws seems to be the most effective way to control free-running dogs. Trapping, poisoning, and shooting are desirable techniques only when methods fail.

A COMPARISON OF THE ACTIVITY AND FEEDING PATTERNS OF THE SHREW, *SUNCUS MURinus* AND BLARINGA BREVICauda. John H. Richardson, Dept. of Biology, Old Dominion University, Norfolk, Va., 23508.

The activity patterns of both shrews show *Suncus murinus* to be more active than *Blarina brevicauda*; *Suncus murinus* travels a greater distance each day than *Blarina*. Feeding experiments demonstrate that *Blarina* can locate most of the available food sources. However, it selects only those foods which yield energy sufficient to warrant pursuit. *Suncus*, on the other hand, demonstrates no such "energy yield" specificity. *Blarina's* inability to fast for extended periods is correlated with its highly acute olfactory capacity for efficient detection of food. *Suncus's* ability to fast for 72 hours is correlated with an inferior capacity for olfactory detection of food. *Suncus's* greater mobility probably compensates for its lower level of feeding efficiency.

PATTERNS OF TEMPERATURE ADAPTATION IN NORTH ATLANTIC COASTAL ACTINIANA. C. Sasseman* and C. P. Mangum, Dept. of Biology, Col. of William and Mary, Williamsburg, Va., 23185.

Although acutely measured rate processes in coelenterates show close correlation with the Van't Hoff Q₁₀ rule, and the distribution of many coelenterate groups is correlated with temperature, little is known about coelenterate temperature adaptation.

Analysis of lethal temperatures shows that the southern distribution of three species of North Atlantic actinians is correlated with their upper lethal temperature. Analysis of oxygen consumption data from acute measurements indicates conformity to the Q₁₀ rule. Oxygen consumption data from animals pre-exposed to various temperatures indicate that oxygen consumption is capable of acclimation to temperature. *Metridium senile* from Massachusetts shows positive acclimation, typical of a poikilotherm partially regulating its metabolic rate in response to temperature change. Two species from Virginia, *Haliplanella luciae* and *Diadumene leucoloma*, appear to show a reverse response pattern. Their response pattern includes encystement and negative adjustment of metabolic rate, showing evasion of rather than regulation to environmental temperature change. (Supported by NSF GB 6884 and GK 4185).

WHAT DO WE KNOW ABOUT THE BIOLOGY OF FRESH-WATER ISOPODS? Arthur J. Seidenberg, Dept. of Biology, Va. Commonwealth Univ., Richmond, 23220.

Considering a total fauna of more than 50 species of fresh-water isopods belonging to the genera *Lirceus* and *Aesellus*, very little is known about their general biology. Life cycles of epigaeic species fall into two basic patterns: those that inhabit "permanent" habitats breed throughout the year; while those in "temporary" habitats have a single, shortened breeding period. Studies on four species of fresh water isopods have indicated that a vernal pond species, *Aesellus* sp., has the shortest duration of development and fastest growth rate. These are of adaptive significance in a temporary habitat. A troglobitic species, *Aesellus* sp., has reduced fecundity and a longer developmental time compared to three epigaeic species. The biology of troglobitic species is not well known. (Supported in part by funds provided by the U. S. Dept. of the Interior as authorized under the Water Resources Research Act of 1964, Public Law 88-379).

METABOLISM OF KREBS CYCLE INTERMEDIATES BY KARLINGIA ROSEA. C. M. Sellers, Jr. Dept. of Biology, Madison Col., Harrisonburg, Va. 22801.

Respirometric studies using a Gilson differential respirometer, showed that homogenates of *Karlingia rosea*, grown on a trypticase, glucose, yeast extract medium, oxidized iso-citrate and succinate. Alpha-ketoglutarate, citrate, fumarate, malate, oxalacetate, and glucose were not respired. Succinate respiration was enhanced by prior exposure to citrate, fumarate, malate, and succinate. Sparked respiration of succinate was inhibited by the introduction of chloramphenicol.

REACTION OF DROSOPHILA MELANOGASTER TO FOOD SUBSTANCES CONTAINING SODIUM CYCLAMATE, CALCIUM CYCLAMATE, AND SODIUM SACCHARIN. R. B. Stith*, N. L. Bannister*, and E. W. Jemison. Dept. of Biology, Va. State Col., Petersburg, Va. 23803.

An investigation was made to determine the effects of cyclamate (cyclohexanesulfamic acid) on *Drosophila melanogaster*. Tests for viability, metamorphic variations and lethality were made. The cyclamate substances A and B were administered to the first instar larvae by addition to the culture medium. Some third instar larvae were sacrificed for chromosomal analysis.

Salivary gland chromosomal smears of second generation exposed Oregon-R larvae showed no chromosomal defects due to cyclamates. Viability varied among six mutants. It was significant that we received a 5.3% mutation rate to lethality on the X-chromosome as compared to the spontaneous mutation rate established in this lab 0.075%.

THE BEHAVIOR WHILE ANESTHETIZED OF THE HYPERKINETIC, SHAKER, AND EITHER A GO-GO NEUROLOGICAL MUTANTS OF DROSOPHILA MELANOGASTER. W. R. Trout, III and W. D. Kaplan*. Dept. of Biology, City of Hope Medical Center, Duarte, Calif. 91010.

H^k, H^k, Sh⁵ and Eag are neurological mutants of the fruit fly which shake their legs vigorously while etherized. Each strain has a characteristic pattern: H^k, H^k, and Eag alternate between fast and slow shaking rates, several times a minute; Sh⁵ has pulses of rapid shaking twice a second. The double mutant H^kSh⁵ has both patterns simultaneously.

The shaking rate increases with adult age to a plateau by the fifth day of about 20 cycles per second, in 3 per cent ethyl ether vapor; it decreases with increasing ether concentration; and it increases with temperature with a Q₁₀ of 2. However, Eag individuals are unusually variable, have a more gradual increase of shaking rate with advancing age, and respond markedly to temperature change. Sh⁵ flies are unusual in that they have bursts of wing scissoring once a second.

Studies are underway on the nature of these genetic defects and their effects upon longevity and behavior while awake.

METABOLIC RESPONSE TO TEMPERATURE CYCLING IN THE FIDDLER CRAB *UCA PUGILATOR*. S. S. Turnip, W. Van Winkle, and C. P. Mangum. Dept. of Biology, Col. of William and Mary, Williamsburg, Va. 23185

Although considerable information is available describing oxygen consumption rate for both cold- and warm-acclimated *Uca* at constant temperatures, little work has been done with cyclic studies. Since natural temperatures are more often fluctuating than constant, an experiment was designed to investigate the effects of fluctuating temperature on oxygen consumption rate of *Uca pugilator*.

Animals were acclimated to 10°C (cold-acclimated) and 20°C (warm-acclimated). Oxygen consumption of cold-acclimated animals was measured first at 10°C and then 15, 20, 15 and 10°C. The oxygen consumption of warm-acclimated animals was measured first at 20°C and then 15, 10, 15 and 20°C.

Cold-acclimated crabs maintained a higher oxygen consumption rate than warm-acclimated crabs at each temperature. Both groups exhibited a range of decreased sensitivity to temperature between 10 and 15°C. A temporary locomotor response to decreasing temperature may have been responsible for oxygen consumption "peaks" which occurred immediately following a temperature change.

THE EFFECT OF ACUTE AND CHRONIC TEMPERATURE INCREASES ON MORTALITY OF THE FALLFISH, *SEMOТИLUS CORPORALIS* (MITCHILL). O. W. Ward and J. R. Reed, Dept. of Biology, Virginia Commonwealth University, Richmond, Va. 23220

Most research concerning the thermal death points in fish has dealt with the upper and lower lethal temperatures. These temperatures may vary among different species and among individuals of the same species depending upon the acclimation temperature. In this study, several experiments were performed to examine the effect of acute and chronic temperature increases on mortality of *Semotilus corporalis*. Two types of tests were performed: One to determine the temperature at which total mortality occurred and another to show the effects of increases to temperatures below that at which total mortality was observed.

GENETIC STUDIES IN HIGHER PLANTS USING ISOCOMES AS MARKERS. J. R. Wall. Dept. of Biology, George Mason College of the Univ. of Virginia, Fairfax, Va. 22030

Species relationships have been studied in the genera *Phaseolus* and *Cucurbita* using isozyme variants as genetic markers. In *Phaseolus* three forms of leucine aminopeptidase (LAP) have been identified and two of these are controlled by codominant alleles of a single locus. In *Cucurbita*, two forms of LAP and two of alpha-naphthyl acetate esterase (Est) have been identified, and both systems are controlled by codominant alleles at each of two loci. No linkage was detected between the two *Cucurbita* loci.

Reciprocal backcrosses of interspecific F₁ hybrids to the parental species (in both *Phaseolus* and *Cucurbita*) reveal differential elimination of donor parent germ plasma through the F₁ gametes for two of the three isozyme markers. In *Phaseolus* the transmission rate of donor parent germ plasma is normal through female gametes but there is a significant departure from expected when transmission is through male gametes. In *Cucurbita* the same result has been obtained for the Est locus, but for the LAP locus no significant difference has been found in the transmission rate of the donor parent allele through male and female gametes. It is concluded from these findings that chromosomal structural differences occur in the region of the LAP locus in *Phaseolus* and in the region of the Est locus in *Cucurbita*. It is further suggested that additional isozyme loci could be used for a more complete genome analysis between species.

PRODUCTION ENERGY OF SOUTHEASTERN WHITE-TAILED DEER AS DETERMINED FROM THE COMPOSITION OF RUMEN DIGESTA. Gary W. Woodward and James B. Whelan. Virginia Cooperative Wildlife Research Unit, Virginia Polytechnic Institute, Blacksburg, Va. 24061.

A model was designed for estimating the amount of food energy consumed which was available for productive purposes in Southeastern white-tailed deer. Estimates from this model indicated that the digestible energy (kcal/kg^{0.75}/day) of natural foods consumed by bucks and does to meet their seasonal growth requirements was 11.6 and 78.1 (Spring), 0 and 15.23 (Summer), 0 and 0 (Fall), and 0 and 93.9 (Winter), respectively. During the fall, neither bucks nor does met their energy requirement for maintenance of body weight. Factors which appear to influence the net energy of food available for productive purposes in the deer are discussed.

Section of Botany

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CHARACTERIZATION OF RIBOSOMES FROM THE SEEDS OF *PINUS LAMBERTIANA*. L. B. Barnett, D. S. Shih*, and R. E. Adams*. Dept. of Biochemistry and Nutrition and Dept. of Forestry and Wildlife, Va. Polytech. Inst., Blacksburg, Va., 24061.

Some physical and chemical properties of ribosomes and ribosomal RNA which were isolated from seeds of *Pinus lambertiana* have been measured. The monoribosome from these seeds had a S_v , 20 = 78.2 and contained 41% RNA and 58% protein.

Upon centrifugal analysis, the ribosomal RNA exhibited two major peaks with $S_{20,20}$ values of 28.0S and 18.2S. The percent nucleotide composition of these RNA's was C = 25.4, G = 30.6, A = 22.9 and U = 21.1 for 28S and C = 23.5, G = 28.5, A = 23.1 and U = 24.9 for 18S. The melting temperature of ribosomal RNA was 76° and the total hyperchromicity was 23% between 22° and 90°.

The 78S monoribosome was transformed reversibly, into a 60S particle when the $MgCl_2$ concentration was lowered from 10 mM to 1 mM. At a lower $MgCl_2$ concentration (0.1 mM), the monoribosome dissociated, irreversibly, into 29S and 37S subunits. (Aided by Hatchet 616070 and McIntire-Stennis 636120).

SOME VEGETATION TYPES OF THE BLUE RIDGE MOUNTAINS. PART I. REVIEW OF LITERATURE. Dorothy C. Bliss. Dept. of Biology, Randolph-Macon Woman's Col., Lynchburg, Va. 24504

Although Virginia played a prominent part in early botanical explorations, there is a serious lack of ecological publications concerning the distribution of plant communities within the state. Articles with some data have been published for a few isolated regions, such as Bull Mountain, Massanumten Mountain and islands off the eastern coast. No literature has been found that pertains specifically to the plant associations of the Va. Blue Ridge or the Va. Piedmont. A brief review of the status of our knowledge of the vegetation of the state as put forth by Lucy Braun and as described in a more recent paper (1969) by Richard L. Hoffman is outlined. Much of the latter discussion is purely subjective and the generalizations should be tested quantitatively.

A preliminary report on some forest types along the slopes of Apple Orchard Mountain is presented and plans for future research are discussed.

FIRE AND THE BRYOPHYTES OF NORTH FLORIDA. D. A. Breil, Dept. of Natural Sciences, Longwood College, Farmville, Va. 23901

Investigations of the bryophyte flora were made in upland pine forests of north Florida following control (= cool) burning. Permanent half acre plots were burned at intervals of 1-4 and 7 years during the spring. Bryophytes were sampled on each 2 series of parallel plots throughout the year. An additional plot was established in a fallow wheat field to study the effects of a "hot burn" fueled by excess combustible ground litter. The results of this investigation indicate that (1) bryophyte succession is dependent upon the density of the developing vascular flora and the ground litter it produces, (2) a number of bryophytes are protected from a cool fire by trees, stumps, and grass clumps, (3) the developing bryophyte flora changes from many small mosses in the first two years to eventual dominance of a few, larger, leafy-forming mosses after 5-7 years, (4) leafy liverworts may be established on both ground and trees by the 7th year after a cool burn, (5) both small mosses and thallose liverworts are pioneers on a hot-burned plot in an open field. (Aided by a Tall Timbers Research Station grant)

CHROMATOGRAPHY OF PLANT PIGMENTS. Robert T. Brumfield and Dorothy F. Chappell. Longwood Col. and Prince Edward Academy, Farmville, Va. 23901

Extract leaf pigments in acetone or alcohol by grinding in a mortar with sand. Centrifuge them with a fine pipette spot the supernatant on TEC film or glass. Develop in four parts petroleum ether and one part acetone. The concept of genetic control of biochemical reactions can be shown by the use of extracts from a variety of plants. The experiment can be completed in a two hour period.

PRELIMINARY KARYOTYPE STUDIES OF EASTERN NORTH AMERICAN CIMICIFUGA. Dennis Canfield*, and Gwynn W. Ramsey. Lynchburg College, Lynchburg, Va. 24504

Preliminary karyotype studies in the Eastern North American *Cimicifuga* verifies the chromosome numbers in the three species as 2N=16. Chromosomal morphologies of the three species are discussed and a comparison is made with Kazuko M. Hasegawa's (1966) Karyotype studies which included *C. racemosa* and *C. cordifolia*.

THE EFFECT OF X-RADIATION ON THE GEOTROPIC RESPONSE OF TIMOTHY ROOTS. Dorothy F. Chappell and Robert T. Brumfield. Prince Edward Academy and Longwood Col., Farmville, Va. 23901

The biochemical control of cell growth and division is not yet known. The effects of X-rays on cell growth and division as measured by the response of the root to gravity may help to clarify the problem. The results of preliminary experiments indicate that X-radiation may effect the geotropic response. Roots turned horizontally immediately after irradiation present a different geotropic curvature from those turned horizontally several hours (six hours) after irradiation.

APLANOSPORE FORMATION AND GERMINATION IN SPIROGYRA SP. Elton C. Cocke and Nathaniel H. Wooding, Jr.* Dept. of Biol., Wake Forest Univ., Winston-Salem, North Carolina 27109.

In the spring of 1969 a species of *Spirogyra* was collected in a shallow stream in Forsyth County, NC. showing definite spore formation. Subsequently the same alga was collected a number of times, at all seasons, over a period of twelve months from the same location and a study made of spore formation and germination. The spores are formed by a marked inflation of the cells near the middle, and a rounding up of the protoplasts into dense spherical masses and the secretion of smooth thick spore walls. No indication of conjugation was observed during the study, the spores are, therefore, considered to be aplanospores. The spores germinate readily in the laboratory after a short period of dormancy. Germination is enhanced by storing ripe spores at a temperature of 8°C for about three weeks. The alga fits well the description of *S. mirabilis* (Hass) Kuetzing, with the notable exception of the shape of the spores which are always spherical and never ovoid as described for *S. mirabilis*.

A STUDY OF THERMAL POLLUTION AND ALgal DISTRIBUTION IN THE LOWER JAMES RIVER. G. S. Grover*, B. R. Woodson, Jr. Virginia State College, Petersburg, Va. 23834

It was the purpose of this study to determine the effects of thermal pollution on the quantitative and qualitative distribution of algae at and below points where cooling water effluents were emptied into the James River by the VEPCO Chesterfield Power Plant in Chester County, Va. Plankton and sessile algae were sampled once weekly beginning November 1, 1969. The results of these studies suggest that algal forms are definitely affected by environmental temperature. A high positive correlation was exhibited between temperature and quantity and quality of algal forms at the control station. However, an equally high negative correlation between these same parameters existed at the direct outfall of the effluents which may be due to much higher temperatures observed at these stations. A low covariance correlation existed at a point 1.5 miles downstream from the effluents and this may be attributed to a growth curve effect resulting from temperatures that range both above and below the optimum. Therefore, a high correlation was attained by fitting the data to a regression line. The succession of species at the control station during this study indicated a predominance of diatoms during the winter months. At points downstream from the effluents the desmids and other green algal forms were found to bloom longer in the fall and earlier in the spring. Also, some species were eliminated below the effluents and others were growing in abundance near the effluent and not at the control station.

TREE IMPROVEMENT PROGRAM OF THE VIRGINIA DIVISION OF FORESTRY. T. A. Diersauf*, Virginia Division of Forestry, Charlottesville, Virginia 22903

The objective of the program is to produce genetically superior pine seedlings for planting in Virginia. Seed orchards are established by grafting. Parent trees are outstanding phenotypes selected for characteristics that are important for timber production, such as straightness, crown size, etc. Fortunately, the characteristics that are important for timber production exhibit considerable variation, and most of them are under reasonably strong genetic control. Thus, there is considerable room for improvement, and chance for genetic gain seem good.

Grafting is done on two year old rootstock, using a side graft. Grafting success averages about 90 percent, and so far about 80,000 grafts have been made. Our goal is about 430 acres of seed orchard, with ultimately about 50 ramefts per acre. A minimum of 20 clones are used in establishing an orchard.

Progeny from each clone will be evaluated using a system of four pollen testers. Controlled pollinations are made when sufficient flowers appear, usually in 5 or 6 years. The results of the progeny tests will indicate any clones that are not superior genotypes, so they can be removed from the orchards. The progeny will also be used to establish even better orchards in the future. Future orchards will be established by grafting from the outstanding progeny produced by the present orchards.

LEWIS GINTER BOTANICAL GARDEN. Reinier Hendriksen* Landscape Architect, Horticulturist, City of Richmond, Va.

In 1916 Miss Grace Arents bequeathed to the City of Richmond, at the death of her companion, Miss Mary Garland Smith, Bloemendaal Farm, app. 70 acres of land in Henrico County. After the death of Miss Smith in 1968 the property came to the City of Richmond. The will stipulated that the property be known as The Lewis Ginter Botanical Garden, in memory of Miss Arents' uncle.

The need for a botanic garden is much greater than most people realize. Botanic gardens can give students in Botany and Horticulture a very valuable aide in their studies. The Richmond location is very desirable as it is within a short distance of several major universities. Also for professional people in these fields it will be a place of learning. The general public with problems in their own environment can find the answers. Programs within the garden would give people, young and old, from the inner city, a chance to come in contact with the growing of plants.

The Mansion itself, with all the beautiful large rooms, offers a wonderful place for an information center, a library, reading rooms and rooms to conduct classes.

I am working on a master plan which I hope will be ready in the near future.

I was fortunate to have the opportunity to exchange ideas with the late Mr. Charles Gillette, who had a wide experience in landscape design.

POINTS OF ORGANIZATION IN CONIFEROUS GROWTH INCREMENTS.
G. Ifju, Division of Forestry and Wildlife Sciences, V.P.I.,
Blacksburg, Va. 24061.

Wood is a heterogeneous but highly organized biological system. Various levels of organization in mature xylem have been investigated. These range from the macroscopic to the microscopic and even to the molecular level. One region of organization, the growth increment, has escaped scientific interest, and variations in xylem properties within this zone are poorly understood at present.

Intra-increment profiles of some physical and chemical properties of several coniferous xylems were constructed using micro-analytical methods. Mathematical models were fitted to the experimental profiles and the patterns so described were related to within-growth-ring xylem anatomy.

Three characteristic patterns of organization could be recognized within coniferous growth increments. These are as follows: 1) Mass ordered pattern, 2) Carbohydrate oriented pattern, and 3) Phenyl oriented pattern. It was found that most physical and chemical properties of wood follow one of the three characteristic patterns of organization within coniferous growth increments.

VARIATION IN NORTH AMERICAN HAMAMELIS L. T. E. Jenney Dept. of Biology, Tidewater Cmty. Col.
Portsmouth, Va. 23703

Hamamelis L. is a small genus of deciduous shrubs or small trees commonly known as witch hazel. According to current taxonomic literature, there are three species of *Hamamelis* occurring in the eastern United States and Mexico. The group presents a confusing array of morphological and geographical variation. There is circumstantial evidence that hybridization, following geographical differentiation of various elements, has contributed to the morphological diversity of the group.

This study was based upon living and dried material as well as field observations, and represents an analysis of morphological variation in North American *Hamamelis* in relation to the geographical distribution of the plants. This study proposes some changes in the rank of the taxonomic categories involved, and tries to assess insofar as possible the evolutionary interrelationships of these units. (based on work done at Vanderbilt Univ.)

THE EFFECTS OF STREPTOMYCIN ON GROWTH AND DEVELOPMENT AND CHLOROPHYLL SYNTHESIS OF TOBACCO CALLUS. R. Lakshminarayanan, and E. Wilson. Dept. of Biology, Virginia State College, Petersburg, Virginia 23803

A study was made on the effect of Streptomycin (SM) on the developing chlorophyll in the callus grown from the pith of *Nicotiana tabacum* var. Wisconsin #38. The synthesis of chlorophyll in the callus in light is completely inhibited by SM in all the three concentrations (0.2%, 0.1%, and 0.05%) used.

Besides inhibition of the formation of a plastid or pigment precursor, a fall in the amount of chlorophyll in the green callus treated with SM, was also noticed.

A parallel study on the effect of SM on the growth of the callus as well as that of the pith revealed the SM inhibited the growth also almost on similar lines to the inhibition of synthesis of chlorophyll.

It is therefore concluded that SM has a general effect on the biosynthesis and that its inhibition on chlorophyll synthesis is merely one consequence of the effect on general biosynthesis.

THE PRELIMINARY RESULTS OF A PHYTO-SOCIOLOGICAL STUDY OF THE UPLAND FOREST COMMUNITIES OF THE VIRGINIA EASTERN SHORE. G. F. Levy, Department of Biology, Old Dominion University, Norfolk, Va. 23508.

A study of the forests of the Virginia coastal plain has been begun with the sampling of 11 forest stands in Northampton and Accomack counties. A system of randomly placed nested circular quadrats had been employed. 25 sets of quadrats have been distributed over 40 acre tracts. These methods have made it possible for a single investigator to study a stand in eight hours. Data collected allowed the computation of density, frequency and dominance which were converted to relative values and summed to yielded Importance Values (IV). Soil samples were collected and percent sand, silt and clay were determined using the hydrometer method. Light meter readings and 12" soil temperature measurements were made. Soil samples were analyzed for major nutrients.

Most upland forests in the area studied were dominated by *Pinus taeda*, while a few stands had *P. virginiana*, as the dominant species. In the 11 stands studied, 8 different species had the second highest IV. The great diversity of sub-dominant species indicate that a forest of great complexity would develop if allowed to grow to maturity. Increment borings indicated that the oldest of the large *P. taeda* individuals was about 90 years old (Aided by ODU Educational Foundation Grant #810).

NOTES ON THE DISTRIBUTION OF GYMNOSPERMS IN VIRGINIA. Peter M. Mazzae, Herbarium, U.S. Nat. Arboretum, Crops Res. Div., Agricultural Res. Service, U.S. Dept. of Agriculture, Washington, D.C. 20002

Recent field and herbarium studies have produced some new distribution data about the native gymnosperms of Virginia. The gymnosperms, found growing naturally throughout the various physiographic provinces of the state, are represented in Virginia by 20 taxa included in nine genera and four families. In addition to these native taxa, there are ten taxa from other areas of the U.S. or the world that have been field planted in Virginia either for reforestation or experimental purposes. Many of these introduced taxa have become established in certain areas of the state.

Although the range maps in this paper show some gaps in the distribution of certain taxa, it is hoped that further work in the field and herbarium will fill in many of these gaps to produce a better known distribution for each gymnosperm in Virginia.

PEOPLE AND PLANTS: A CASE OF MULTIPLICATION AND SUBTRACTION. R. Alan Mebane, Environmental Education Specialist, U. S. Dept. of Interior, National Park Service, Richmond, Va. 23240

Awareness of environmental deterioration has spread nationwide in the last two years. President Nixon's messages, news media, and the recent Teach-In on the environment focused needed attention on wide-ranging, interrelated problems. Each of us shares responsibility, due to demands and acceptance of often unneeded products. Americans consume half of the world's production of raw materials annually. Growth of world's human population traced from 6000 B. C., showing doubling time reduced from 1000 yrs. to 35 yrs. Control of population increase vital.

Comparison of Apollo 13's problems to earth's life support system. Spaceship philosophy can lead to earthmanship, better ecological management. Environmental education of public, particularly children, is suggested as positive route to improvement. Programs of the National Park Service are described, including school's use of Environmental Study Areas (ESAs). Man-centered approach is stressed in teaching the interrelationships of the web of life.

Urge those with ecological knowledge to help promote environmental awareness. Citizens are ready to find solutions, and guidance is needed.

INTERESTING PLANT FINDS FROM THE SOUTHERN VIRGINIA PIEDMONT. Gwynn W. Ramsey. Lynchburg College, Lynchburg, Va. 24504

Ecological-floristic investigations during the past year have resulted in the finding of a number of plants not reported previously for the Piedmont Province or State. Some of these plants are interestingly distributed in nearby States. The need for floristic research in the State is emphasized.

SEASONAL PERIODICITY OF PHYTOPLANKTON IN SILVER LAKE, ROCKINGHAM COUNTY, VIRGINIA. Gary L. Spitzer and J. Elwood Fisher, Dept. of Biology, Madison College, Harrisonburg, Va. 22801

This investigation is concerned with the limnology of a small reservoir lake in the western part of Virginia. It is a preliminary study which attempts to establish the taxonomic identity of the phytoplankton and detect any seasonal, as well as, diurnal fluctuations correlated with the prevailing physical and chemical conditions of the lake. *Spirogyra*, desmids and diatoms were present in all collections while *Dinobryon divergens* was dominant during the summer months. The lake was oligotrophic in productivity which is characteristic of older established hardwater lakes. The numbers and species of phytoplankters present varied with the seasonal conditions. A total of 94 genera were collected from the lake during the study period which extended over twelve months.

ENDOGENOUS CONTROL OF GROWTH AND DORMANCY IN *TALINUM* RHIZOMES. Stewart A. Ware, Dept. of Biology, Col. of William and Mary, Williamsburg, Va. 23185.

Plants of *Talinum calcicarum* and *T. mengesii* (Portulacaceae) die back to their rhizomes each fall. In these species the period of the growth cycle and the onset of dormancy are apparently endogenously controlled, for dormancy ensues even though there has been no change in environment during the entire life of the plant, and the length of the growth period is consistent under a variety of conditions. It was found experimentally that they become dormant regardless of favorable conditions of temperature, water relations, light intensity, photoperiod, and substrate conditions. This onset of dormancy in *T. calcicarum* occurs 23 weeks after the rhizomes break dormancy or the seeds germinate. Once dormant, the rhizomes will not grow again until subjected to cold treatment for 6-8 weeks. Simple after-ripening for as long as three years did not substitute for cold. Both the length of the growth cycle and the requirement for cold treatment are in harmony with the natural environment within the geographic ranges of these two species.

GO WET YOUR FEET, YOUNG BOTANIST. Marvin L. Wass. Va. Institute of Marine Science; Sch. of Marine Science, Col. of William and Mary; Dept. of Marine Science, Univ. of Va., Gloucester Point, Va. 23062

The extent of botanical collecting is indicated by the numbers of wetland and dune plants listed in Massey's Virginia Flora. While 468 such plants are listed from Princess Anne County, less than 20 species are listed from 10 of the 26 coastal counties. Our random collecting disclosed 22 species unreported from Accomack County on Cedar Island alone. Swamps, marshes and islands are under increasing cultural pressure. Thorough studies ought to be directed to them before a definitive floral work on Virginia is published.

THE EFFECT OF CHLORAMPHENICOL ON GROWTH DEVELOPMENT AND CHLOROPHYLL SYNTHESIS IN TOBACCO CALLUS. T. Wynn, and E. Wilson. Dept. of Biology, Virginia State College, Petersburg, Virginia 23803

A study was made of the effect of chloramphenicol on the growth development and chlorophyll synthesis in the callus grown from pith cells of *Nicotiana tabacum* var. Wisconsin #38. Growth and chlorophyll synthesis was partially inhibited in the lower concentrations 0.005 mg/ml and 0.01mg/ml, and almost completely inhibited in the higher concentrations 0.08 mg/ml to 0.2 mg/ml in the light grown callus. Callus treated with 0.005 mg/ml and 0.01 mg/ml of cm were transferred on control medium and growth and resynthesis of chlorophyll was observed. There was only minimum growth and little or no resynthesis of chlorophyll observed in 0.08 mg/ml to 0.2 mg/ml of cm treated callus transferred to control medium.

Parallel studies on the effect of chloramphenicol on the growth of the callus and pith treated prior to callus formation were also partially inhibited. The effect of delta-aminolevulinic acid on chlorophyll productivity was also investigated.

It is therefore concluded that chloramphenicol has a general effect on growth development and chlorophyll synthesis in tobacco callus.

Section of Chemistry

Forty-eighth Annual Meeting of The Virginia Academy of Science
May 6-8, 1970, Richmond, Virginia

ALKALINE REDUCTION OF THE SEMICARBAZONES OF α,β -UNSATURATED KETONES IN APROTIC SOLVENT. Daniel W. Armstrong*, David C. Collins*, Joseph B. Phillips III*, Robert T. Schooley*, James K. Shillington, Robert M. White*. Dept. of Chemistry, Washington and Lee Univ., Lexington, Va. 24450

A study of the effects of basic aprotic environments on the reduction of α,β -unsaturated ketones has been undertaken. The semicarbazone derivatives of selected keto containing compounds have been prepared and reduction by KOH in boiling DMSO and K *tert*-butoxide in DMSO at room temperature has been assayed. The effect of various mole-ratios of starting materials on reflux reduction yield with strong alkali and high boiling solvent also was studied. Definite advantages of carefully dried DMSO over untreated solvent were evident. Reduction at room temperature with anhydrous DMSO and K *tert*-butoxide was unproductive. (Aided by NSF grant GY 6100 and by Robert E. Lee Research Grants.)

AN EVALUATION OF SPECTROCHEMICAL AND SPECIFIC ION ELECTRODE MEASUREMENTS IN THE DETERMINATION OF THE TRACE INORGANIC COMPOSITION OF RIVER WATER. Anne L. Bates* and Bernard L. Mahoney. Department of Chemistry, Mary Washington College, Fredericksburg, Va. 22401

A study has been made of the relative precision and accuracy of the Orion divalent cation electrode (DCE), atomic absorption (AA), and EDTA methods for water hardness determinations of Ca and Mg in soft river water. The DCE determinations consistently gave higher results than the AA analyses but agreed favorably with EDTA titrations. The differences between the AA and DCE results appear to be due to the presence of trace amounts of Cu, Zn, Fe and other divalent cations. Undetermined positive errors were also attributed to the presence of sodium and ionic strength changes associated with the standard addition method.

In general, the measurement of divalent cation concentrations in soft water rivers by AA and DCE methods give results which are in good agreement provided corrections for trace metal interferences and ionic strength can be made. Under these conditions, DCE measurements require less time and sample preparation compared to AA and EDTA methods while offering comparable sensitivity and accuracy.

ISOLATION AND IDENTIFICATION OF CHOLESTEROL FROM *dactylometra quinquecirrha*. F. T. Bishop and C. E. Bell, Jr., Dept. of Chemistry, Old Dominion University, Norfolk, Va. 23508.

Lipid extracts of *dactylometra quinquecirrha* were examined using TLC techniques. Crystals of cholesterol were isolated by preparative TLC and identified by melting point and infrared data. An interesting and as yet unexplained IR peak is present in the residue of the cholesterol fraction at 1940-1960 cm^{-1} . Work planned for the future is described.

PYHSICOCHEMICAL STEREOSPECIFICITY IN TASTE PERCEPTION OF α -D-MANNOSE AND β -D-MANNOSE. Christine K. Carrico, Roberta A. Stewart, Ralph G. Steinhardt, Jr., Ronald L. Webster, Depts. of Chemistry and Psychology, Hollins Col., Va. 24020

Extremely strong correlation between structure and taste is observed using α -D-mannose and β -D-mannose as test substances. The slight structural difference between the anomers is sufficient to cause the α -anomer to have a sweet taste and the β -anomer to have a bitter taste.

A SIMPLIFIED TECHNIQUE FOR DETERMINING DYNAMIC SURFACE TENSION. Jerry A. Caskey, Dept. of Chem. Engr., Va. Polytechnic Institute, Blacksburg, Virginia, and William E. Barlage, Jr., Dept. of Chem. Engr., Clemson Univ., Clemson South Carolina.

Oscillating jets issuing from elliptical orifices have been widely used as a method for determining the dynamic surface tension of pure liquids and surfactant solutions. However, such variables as jet diameter and wave length have been measured by combined optical and photographic methods. A technique is presented for direct measurement of these data on the jet using a coordinate cathetometer. The jet stream was vertical and issued from an elliptical diaphragm orifice made of 2 mil Mylar film. The orifice was made non-wetting by carefully coating it with paraffin. This jet was found to give values of dynamic surface tension for water which were independent of exposure time and jet flow rate, and agreed closely with equilibrium values. For the surfactant solutions studies, values of dynamic surface tension were also found to be independent of any jet flow rate used. Four surfactants were used in the investigation: dodecytrimethylammonium chloride, hexadecyltrimethylammonium chloride, dodecyl sodium sulfate and hexadecyl sodium sulfate.

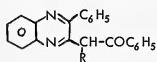
FORMATION AND REACTIONS OF IONS IN THE MASS SPECTROMETER. C. E. Compton*, Department of Chemistry, Hollins College, Hollins, Virginia, and J. G. Dillard, Department of Chemistry, Virginia Polytechnic Institute, Blacksburg, Virginia 24061

The formation and reactions of negative ions are important in understanding reactions in gaseous discharges, in helping to describe the reactive species in electrochemical processes, and in attempts to describe the bonding in negative ions and the location of the charge in stable anions. Unimolecular ionic decomposition reactions have been examined for a series of phosphorus and arsenic halides and for a group of oxy- and thio-phosphorus halides. The primary fragment negative ions are formed via dissociative electron capture reactions. It is noted in several instances that parent negative ions are formed by direct electron capture. From the magnitudes of the calculated electron affinities for the phosphorus halogen and the oxy- and thio-phosphorus halogen species, it is suggested that the electron affinity is most closely associated with electron location in orbitals dominated by contributions from the halogen species.

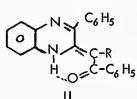
THE REACTION OF *o*-PHENYLENEDIAMINE WITH CERTAIN α,β -UNSATURATED DIKETONES. TAUTOMERISM OF 3-PHENYL-2-PHENACYLQUINOXALINE AND SOME OF ITS DERIVATIVES.

David D. Crichton, III* and R. G. Bass, Dept. of Chemistry, Virginia Commonwealth Univ., Richmond, Virginia 23220

The enol and furanone forms of 1,2-diphenylbutane-1,2,4-triones are reported to react with *o*-phenylenediamine to yield 3-phenyl-2-phenacylquinoxalines (I).



I R = H, CH₃, Br, C₆H₅CO



Using ir and nmr, it was found that in the case when R=H the quinoxaline exists in the enamine form I and when R=CH₃, Br, or C₆H₅CO the quinoxoline form I predominates.

trans-Dibenzoylethylene on reaction with *o*-phenylenediamine in 95% ethanol or benzene underwent a novel condensation-elimination reaction to yield 2-phenylquinoline along with acetophenone.

With dibenzoyloctene, *o*-phenylenediamine reacts to give II. Benzolacophenone and cis-dibenzylstyrene did not react with *o*-phenylenediamine in refluxing 95% ethanol.

A MODEL SYSTEM FOR MOLECULAR AGING AND SENESCENCE. L. Gordon Fels, Division of Biochemistry, Va. Inst. for Sci. Res., Richmond, Va. 23226

The kinetics of breaking stretched rubber bands is found to be similar to that exhibited by senescent biological populations. The elements of the senescent system are described as an energy displacing force, a counter-acting force, and a spontaneous reaction altering the structure of a component in the system. For Gompertzian kinetics to be obeyed, the latter reaction is limited to those whose kinetics are a function of e^t. These are free radical oxidation, molecular ordering and inorganic crystallization. The relevance of the model to biological systems will be discussed.

A NEW EVALUATION OF THE HYBRIDIZATION ENERGY OF THE CARBON BONDS. L. I. Epstein, Dept. of Biophysics, Va. Commonwealth Univ., Health Sciences Div., Richmond, Va. 23219.

New self-consistent field calculations on the carbon atom by E. U. Condon and H. Odabasi make possible a new evaluation of the hybridization energy of the carbon bonds. The method of J. H. Van Vleck has been used and will be briefly reviewed.

MÖSSBAUER STUDIES OF METHANOL OXIDATION ON A SUPPORTED IRON CATALYST. H. M. Gager*, J. F. Lefelholz, Depts. of Chem. & Phar. Chem., VCU, and M. C. Hobson, Jr., Va. Inst. for Sci. Res., Richmond, Va. 23226

The Mössbauer Effect has proven to be a useful tool for determining the structure of solid surfaces. Catalyst samples were prepared by impregnating silica gel with Fe-57 enriched nitrate solutions. In its oxidized state the iron shows a broad doublet characteristic of ferric ions in the Mössbauer. Reduction in flowing hydrogen at 600°C resulted in a three peak Mössbauer spectrum (two super-imposed doublets) assigned to ferrous ions in two different environments. Chemisorption of methanol resulted in a decrease in the quadrupole splitting on the oxidized sample and a loss of one of the doublets in the reduced sample. Desorption from the reduced sample indicates the presence of methanol, condensable products, and non-condensable gases but the Mössbauer spectrum is returned to the original three peak spectrum. Outgassing, following chemisorption of methanol on a partially oxidized sample, did not yield the original spectrum. The catalyst appeared to be highly reduced. The changes in the spectra resulting from the chemisorption will be discussed in terms of the formation of surface complexes between the adsorbate and the surface species.

USE OF A SMALL COMPUTER IN MASS SPECTRAL PEAK ANALYSIS.
R. C. Gray* and J. G. Dillard, Dept. of Chemistry,
Virginia Polytechnic Inst., Blacksburg, Va. 24061

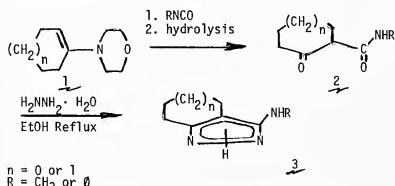
The determination of the elemental composition represented by a particular m/e peak in a mass spectrum is often a difficult problem due to the variety of atom combinations which can give rise to the same nominal mass. A program for use with a small lab type computer has been developed to calculate the probable composition of mass peaks from a high or low resolution mass spectrum. The program permits evaluation of the composition of any mass peak with up to seven different isotopic masses. The output includes the calculated mass, its error from the actual mass, and the probable empirical formula. The program operates for any specified error limit and allows for punched tape input as well as teletype input. The utility and limitations of the program will be presented and discussed.

A CHEMICAL STUDY OF CIMICIFUGA RACEMOSA (BLACK SNAKERoot). Terry L. Harris* and Samuel J. Gamble. Dept. of Chem., Lynchburg College, Lynchburg, Va. 24504

Cimicifuga racemosa (Black Snakeroot) has been extensively studied by Dr. Gwynn Ramsey, botanist from Lynchburg College. It was selected for chemical examination in a search for possible key chemicals that could be used in chemical taxonomy. Approximately 300 grams of the roots was extracted with the usual solvents. Each fraction was separated into its acidic, basic and neutral components. One of the neutral components has been examined in some detail. Some white crystals were found in the methyl alcohol fraction after long standing. These crystals had a melting point of 189-190°C. and gave a positive test with Benedict's reagent. The crystals formed a syrupy liquid with water and had a sweet taste, suggesting a sugar component. Specific rotation, osazone and acetate derivatives plus chromatography were used to assist in identification.

3,4- AND 4,5-POLYMETHYLENEPYRAZOLES. R.T. Kemp, K. Gilmore* and B.F. Anthony*. Naval Weapons Lab., Dahlgren, Va., 22448

Polymethylenepyrazoles were prepared from cyclopentanone and cyclohexanone via enamine and β -ketoamide intermediates by reaction of the latter with hydrazine hydrate.

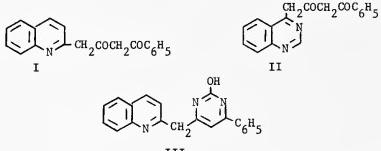


The prevalent position of the tautomeric hydrogen of the pyrazole moiety may be related to stabilities of exocyclic versus endocyclic unsaturation in the carbocyclic rings, as suggested by the structural assignments for 3a and 3b.



REACTIONS OF CERTAIN HALOGENATED HETEROCYCLES WITH 1,3-DICARBONIANS. J. C. Greene* and J. F. Wolfe. Dept. of Chemistry, Va. Polytechnic Inst., Blacksburg, Va. 24061

In connection with a study of reactions of halogenated heterocycles with multiple anion intermediates, we have found that treatment of the benzylacetone dicarbanion with 2-chloroquinoline in liquid ammonia results in formation of quinolinyl β -diketone I. Similarly, treatment of this dianion



with 4-chloroquinazoline affords the analogous quinazolinyl β -diketone II. Urea cyclization of I yields pyrimidine derivative III, which can also be prepared via reaction of 2-chloroquinoline with the dianion of 2-hydroxy-4-methyl-6-phenylpyrimidine.

SYNTHESIS OF POLYNUCLEAR AROMATIC COMPOUNDS FOR MUTAGENICITY STUDIES. Paul D. Henson, Bill DuVal*, Steve Ockrymick*, Ann Boucher*, and Jill Brandt*. Dept. of Chemistry, Roanoke College, Salem, Va.

The theory that polynuclear aromatic hydrocarbons and derivatives cause cancer either by interfering with genetic regulation or inducing somatic mutation has prompted the synthesis of several sulfur analogs of carcinogenic hydrocarbons for examination of mutagenic properties in fruit flies and certain bacteria. Sulfur analogs of benzanthenracene, dibenzanthracene, pyrene, and perylene ring systems have been synthesized. Synthetic procedures as well as spectral characteristics of the compounds will be presented.

THE USE OF GAS CHROMATOGRAPHY FOR INTRA-INCREMENT CARBOHYDRATE ANALYSIS OF WOOD AND PULP. P. Labosky, Jr., Division of Forestry & Wildlife Sciences, V.P.I. Blacksburg, Va. 24061

A Perkin Elmer 900 gas chromatograph equipped with a flame ionization detector was used for the intra-increment carbohydrate analysis of wood and pulp. A $3' \times 1/4"$ O.D. column packed with 3% ECNSS-N on Gas Chrom 0 was used with a helium flow rate of approximately 90 cc/min. The column was operated at 195°C with an injection port temperature of 200°C. The manifold temperature setting was at 250°C. Volatile derivatives of alditol acetates of the monosaccharides obtained from pulp and wood meal were prepared using the method of L. G. Borchardt and C. V. Piper.

Satisfactory separation of the five sugars normally found by the hydrolysis of wood and pulp was obtained using the above procedures. Other investigators used 6' columns to achieve the desired resolution; whereas, in this study satisfactory results were obtained with a 3' column. Some difficulty was encountered with the hexoses in that there was not complete resolution; however, sufficient separation did occur which enabled the investigator to obtain quantitative determinations.

In this study it was observed that the xylose derivative tailed extensively. Other investigations did not report this phenomena. This tailing was observed when calibrating the known sugars and with the analysis of wood and pulp. No explanation can be given as to what caused this problem.

THE STRUCTURE OF CHOLINE PLASMALOGENS FROM COW'S MILK. Ann Scott Lankey* and Lawrence A. Wishner. Dept. of Chemistry, Mary Washington Col., Fredericksburg, Va. 22401

The structure of beef heart phosphatidyl choline is known from degradative studies and from the isolation of a pure native choline plasmalogen by means of the selective hydrolysis of the phosphatidyl choline component of beef heart lecithin by *Crotalus atrox* venom. The latter procedure, based on the assumption that the vinyl ether linkage was in the 1- position as in beef heart, and that *C. atrox* venom promotes the selective hydrolysis of the fatty acid in the 1- position, was applied to cow's milk lipids.

Since IR spectroscopy revealed that the vinyl ether absorption remained in the hydrolyzed (lyssolecithin) fraction, it is suggested that the vinyl ether linkage is in the 2- position of the choline plasmalogens of cow's milk.

A HEXADECANT RULE FOR OPTICAL ACTIVITY IN PLANAR TRANSITION METAL ION COMPLEXES OF AMINO ACIDS AND PEPTIDES: R. Bruce Martin. Dept. of Chemistry, Univ. of Va., Charlottesville, Va. 22901.

Divalent copper and palladium ions form tetragonal complexes with amino acids and dipeptides. Both of these metal ions and nickel ion form planar complexes with tripeptides. When all amide hydrogens have been ionized in the peptide complexes relatively rigid structures are indicated with specific side chain dispositions. Cotton effects observed in the ligand field bands of the metal ions for dipeptide complexes M(X-X') may be predicted by adding the results for M(gly-X) and M(X-gly) where gly represents a glycyl and X an L- or D- amino acid residue. These results and those for tripeptides cannot be accounted for by any simple octant rule. A hexadecant rule accounts for the magnitude additivity observed in these complexes. To form hexadecants the coordination plane about the metal ion is divided perpendicularly into eight sectors of alternating sign centering on the metal ion. Sectors on opposite sides of the chelate plane also possess opposite signs. Side chains of L-amino acid residues of tetragonal metal ion complexes of di- and tripeptides all fall into hexadecants of identical sign, accounting for the results.

CATALYSIS OF REDOX REACTIONS BY NOBLE METAL SURFACES. J. G. Mason and R. A. Swirsky.* Dept. of Chemistry, Va. Polytechnic Inst., Blacksburg, Va. 24061

Detailed kinetics of the catalysis of a variety of inorganic reactions by gold and platinum surfaces have been obtained. For the Fe(II)-quinone, Ce(IV)-Tl(I), Ce(IV)-Hg(I) reactions the rate of catalysis has been found to be proportional to the surface area and quantitatively equal to a slower rate of mass transport. The Fe(III)-Sn(II) reaction in $HClO_4$ showed no catalysis. Comparison of the catalytic rates with electrochemical current-voltage curves rules out an electrochemical interpretation of the catalytic action of gold surfaces. The Ce(IV)- H_2O reaction, however, does proceed by essentially an electrochemical mechanism.

ELECTRIC FIELD GRADIENT ASYMMETRIES AND MOSSBAUER QUADRUPOLE SPLITTINGS OF STANNOUS COMPOUNDS. John F. Lefebvre, Dept. of Chemistry and Pharmaceutical Chemistry, Va. Commonwealth Univ., Richmond, Va. 23219

All Sn(II) compounds which have been investigated by the Mossbauer effect exhibit quadrupole splittings ranging from 0.50 mm/sec to 2.39 mm/sec. The use of narrow line ^{119}Sn source matrices such as $PdSn$, Mg_2Sn and $BaSnO_3$ lowers the limit of quadrupole splitting resolution for Sn(II) compounds to 0.50 mm/sec. This lower limit is approximately 1.0 mm/sec when the wide line source SnO_2 is used. These quadrupole splittings are the result of the interaction of the quadrupole moment of the tin nucleus with the asymmetric electric field gradient about the tin. The asymmetry is caused by the unequal occupation of the tin p orbitals. A distortion in the electric field gradient in the p_{x-y} plane at one extreme will be one half of that observed for a distortion of the electric field of equal magnitude along the p_z axis at the other extreme. A correlation plot (isomer shift versus quadrupole splitting) of Mossbauer data for Sn(II) compounds on or between the limits of the two extremes of electric field gradient asymmetries. Generally, donors which may be classified as soft acids will give rise to p_x distortions, and as the hardness of the donors increase the distortions will yield p_y asymmetry. A relationship between the electronegativity of the element bonded to tin in a particular compound and the position of the compound on the isomer shift versus quadrupole splitting graph will be discussed.

THE KINETICS OF THE CHLORINE OXIDATION OF CYCLOHEXANOL. J. G. Mason and L. G. Baird.* Dept. of Chemistry, Va. Polytechnic Inst., Blacksburg, Va. 24061

The kinetics of the chlorine oxidation of cyclohexanol have been measured using an amperometric technique. The rate law found is

$$\frac{d[C_2]_1}{dt} = k[R OH][C_2]$$

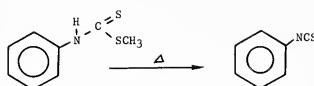
The temperature coefficient of the rate constant has been measured and the activation parameters determined. At 300°C, the rate of oxidation of cyclohexanol by chlorine is approximately 6 times faster than the corresponding oxidation of 2-propanol. The oxidation product, cyclohexanone, is also more reactive towards chlorine than is acetone.

A STUDY OF THE THERMAL DECOMPOSITION OF 1,1-DIPHENYLPROPYL HYDROGEN PHthalATE ESTER IN SOLUTION. Raphael M. Ottenbrite and James W. Brockington. Dept. of Chemistry, Va. Commonwealth Univ., Richmond, Va. 23219

Decomposition studies at temperatures above 110°C of *cis* and *trans*-1,2-dimethyl and 1-phenyl-2-methylcyclohexyl hydrogen phthalate ester to yield olefin and phthalic acid have recently been performed (Rutherford and Wassenaar, Univ. of Windsor, Windsor, Ontario, private communication). These studies indicated that some ionic or radical cleavage occurs before olefin formation. Recently we have accomplished a more thorough study of the thermal decomposition of 1,1-diphenylpropyl hydrogen phthalate ester and derivatives in DMSO and mixtures composed of DMSO and less polar solvents at temperatures below 100°C. The only products in DMSO and solvent mixtures incapable of solvolysis are 1,1-diphenylpropene and phthalic acid. Rate constants and activation parameters have been obtained from several solvent systems using NMR techniques to follow the kinetics. The variations in the rate constants as a function of the solvent composition have been obtained in mixtures of DMSO-benzene and other solvent pairs.

A STUDY OF DITHiocARBAMATE ESTER PYROLYSIS. Raphael M. Ottenbrrite and Arvid Nelson, Dept. of Chemistry, Va. Commonwealth Univ., Richmond, Va. 23219

Methyl dithiocarbamate esters of several amines have been prepared. On pyrolysis, at temperatures ranging from 150 to 170°, these dithiocarbamate esters decomposed to yield the corresponding isothiocyanate in very good yields:



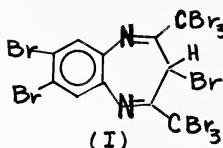
This process has been found to be applicable to various aniline systems as well as primary and secondary alkyl amine systems.

THE GREEN ISOMER OF THE DIBROMOTRIS(DIPHENYLPHOSPHINE) COBALT(II) COMPOUND. Donald L. Plymale and Lucy A. Cline*, Chemistry Department, Roanoke College, Salem, Va. 24153.

An improved technique for synthesis of the green cobalt (II) bromide complex with diphenylphosphine is reported along with a characterization of the structure. In methanol the complex decomposes rapidly and makes questionable some of the previously reported properties. A tetrahedral configuration is observed for the cobalt ion; however, an octahedral-tetrahedral environment appears consistent with the overall configuration of the cobalt.

BROMINATION STUDIES OF THE 2,4-DIMETHYL 1,5 -BENZODIAZEPINE RING SYSTEM. Walter C. Peaston, R. L. Williams and Miss J. Bradley. Dept. of Chem., Old Dominion Univ., Norfolk, Va. 23508.

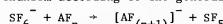
The bromination pattern of the 2,4-dimethyl-[1,5]-benzodiazepin has now been carefully re-evaluated and the isolation and identification of a new, highly brominated species (I) will be presented together with additional synthetic work.



NEGATIVE ION-MOLECULE REACTIONS OF INORGANIC HALIDES.

T. C. Rhyne* and J. G. Dillard. Dept. of Chemistry, Virginia Polytechnic Institute, Blacksburg, Virginia 24061

Negative ion-molecule reactions have been studied using a mass spectrometer to detect the ionic reactants and products of the reactions under consideration. The mass spectrometer has been modified for these studies so that high ion source pressures (0.1 to 10 microns) may be obtained, and the instrument was interfaced with a laboratory computer for direct digital data acquisition and signal averaging of the mass spectrometer output. In the study negative ions produced in SF₆ by low-energy electron capture processes were observed to react with non-metal halides via a fluorination transfer mechanism according to the general reaction:



Comparison of the electron capture ionization efficiency curves of primary ions SF₆⁻ and SF₅⁻ and secondary ions at low electron energies enables identification of SF₅⁻ as the reactant ion, and examination of the pressure dependence of the primary and secondary ion currents confirms that the reactions are simple bimolecular processes. Reactions involving the inorganic halides BF₃, SiF₄, PF₅, and PF₃ have been observed, and reaction cross section and reaction rate constant data have been obtained as a function of ion energy for these reactions.

A PHYTOCHEMICAL ANALYSIS OF MONOTROPA ONIFLORA (INDIAN PIPE). Clark T. Scully* and Samuel J. Gamble. Dept. of Chem., Lynchburg College, Lynchburg, Va. 24504

Monotropa oniflora (Indian Pipe) was selected as a non-chlorophyll plant to be examined for possible chemicals useful for plant taxonomy and for any chemicals having antibiotic properties. Approximately 35 grams of the plant was extracted with petroleum ether, diethyl ether and methyl alcohol. The ether extract was separated into its components (acidic, basic and neutral). From the basic component was obtained an unknown which was purified by column chromatography. After recrystallization the sample gave a positive ferric chloride test for phenol. The melting point was found to be 211-213°C. Further identification characteristics on the small amount isolated are indicated from NMR, IR and UV spectral data.

INTERMEDIATE SOLVOLYSIS PRODUCTS OF THE NICKEL(II) COMPLEXES OF THE CYCLOTETRAMERIC SCHIFF BASE OF o-AMINOBENZALDEHYDE. L. T. Taylor, Dept. of Chemistry, Va. Polytechnic Inst., Blacksburg, Va. 24061, V. Katovic* and D. H. Busch*. Dept. of Chemistry, Ohio State Univ., Columbus, Ohio 43210

Nucleophilic addition reactions to cyclohexameric Schiff base nickel(II) complexes have been extended to diol anions, amines and diamines. The incorporation of two amine or alkoxy functions into the complex is demonstrated by analytical, molecular weight and mass spectral data. The resulting inner chelates which are stabilized by the macrocyclic chelate ring have been formulated as the partially solvolyzed complexes containing either two ionized α-amino ether or *gem*-diamine functions. With bis-(2-hydroxyethyl)methylaniline or bis(2-hydroxyethyl)sulfide as the nucleophile, a new and unusual "basket-like" polycyclic ligand is formed. These results are based on infrared, visible and mass spectral evidence.

BICYCLICS: III. George S. Whitney, Dept. of Chemistry Washington and Lee University, Lexington, Virginia 24450

A well-known method for producing a tricyclic compound from a bicyclic ketone consists of treating its p-toluenesulfonylhydrazone with sodium in acetamide. We have continued our study and extended it to include several compounds which are not bicyclics.



In some cases the products are not singular. This factor coupled with low yields and reagent expense make the reaction mostly of academic interest. The work was done by G. Hoy Widener, Arthur Cleveland and Frank Fisher.

POLYIMIDAZOPYRROLONE MODEL COMPOUNDS. Philip R. Young, NASA, Langley Research Center, Hampton, Va. 23365

A model compound study of the polyimidazopyrrolones (Pyrrones) has been performed. The reactions of phthalic anhydride and *o*-phenylenediamine were studied under conditions analogous to polymerization and post cyclization. The route from the intermediate amide-acid-amine to the tetra-cyclic benzoylenebenzimidazole when the reactions are conducted in aprotic solvents is highly competitive between the intermediate benzimidazole-acid and imide-amine. Solid state thermal conversion of this intermediate affords a unique dimeric species containing amide, imide, and benzimidazole functions. It was confirmed that melt techniques lead to disproportionation products.

Section of Engineering

Forty-eighth Annual Meeting of The Virginia Academy of Science
May 6-8, 1970, Richmond, Virginia

HOT TORSION TESTING OF ALUMINUM ALLOYS AND ITS APPLICATION TO HOT WORKING

C. Baker, Reynolds Metals Company, Richmond, Va.

A number of aluminum alloys have been tested in torsion at temperatures above one half the absolute melting temperature and in a strain rate range of 0.01 sec^{-1} to 12 sec^{-1} . Stress data from these tests was analyzed according to the relationship suggested by Sellars and Tegart:

$$\gamma = A \sinh (\alpha \tau)^n \exp \frac{-Q}{RT}$$

The fit to this equation was good in all alloys over a wide range of temperature and strain rate and values of n , Q and A were computed.

In addition, the strain to fracture was computed and used to determine the temperature and strain rate ranges for maximum ductility. The behavior varied and a maximum which depended on strain rate was observed in some ductility versus temperature curves suggesting an optimum hot working range.

This data has been utilized in computer simulations of hot working processes and in plant trials of new alloys.

ITERATIVE TECHNIQUE USING A LASER FOR ALIGNMENT OF THE MACH-ZEHNDER INTERFEROMETER

J. Dexter Bird, III^a and Charles S. Chen^b, Dept. of Mechanical Engineering,

Univ. of Va., Charlottesville, Virginia 22901

An iterative technique using a continuous gas laser is described for alignment of a Mach-Zehnder interferometer, for monochromatic as well as white light fringes. Simple rotational and translational adjustments were used in search for parallelism and equal pathlengths between splitted light beams. A cross-hair slide projection on the screen was used to help determine the degree of superposition of images. Cause of circular fringes and means of eliminating this undesirable feature are explained. Auxiliary apparatus required consists of one continuous gas laser, one plane mirror, one cross-hair slide, one slide projector, and one projection screen.

PROBLEMS ENCOUNTERED IN BUILDING AN NEW DESIGN STACK SAMPLER
John T. Chehaske* and Edwin Cox III. Commonwealth Laboratory Incorporated, 2209 E. Broad St., Richmond, Va. 23223

Because of the ever increasing interest in air pollution, many governmental bodies are enacting powerful laws which arm control agencies with the necessary authority to effectively curtail air pollution. To be effective such legislation must first define maximum allowable limits for concentrations of various pollutants. Before action can be taken against a suspected violator, direct sampling and analyses of plant effluent streams is often required. Such tests must be extremely thorough and accurate. To meet these requirements the NEW stack sampler was developed.

The stack sampler was designed and built by the Engineering Control Section, Control Development Program, Public Health Service, Bureau of Disease and Environmental Control, U.S. Department of Health, Education and Welfare. A rough draft giving construction details was prepared by the National Air Pollution Control Association. Based upon this rough draft, Commonwealth Laboratory Incorporated undertook the project of building such a stack sampler.

This paper describes the basic construction and operating details of the NEW stack sampler. It further describes the multitude of problems encountered during the construction of the equipment caused by the sketchy and often inaccurate data contained in the rough draft construction details. Solutions to these problems are presented.

APPLICATION OF FLUIDIC CONTROL PRINCIPLES TO UNDERWATER MACHINERY. J. M. Freeman, Jr., Univ. of Denver, Denver, Colorado 80220.

A fluidics control system was designed, modeled, and tested for the operation of an underwater fluidic steam shovel in an ocean (electrolyte) environment. Specific problems considered were the expansion of a gas through a small orifice, bending stress in the members, piston sizes, the materials of construction (aluminum), hardness of the ocean floor and pressure drop of the air due to external water pressure. The basic device constructed for demonstrating the fluidic control system consisted of three pistons and two turbines which worked on a memory principle. The basic control system for the pistons and the turbines, could be used for full size underwater shovel with the addition of interface power boosters to handle a large volume of flow.

PROBLEMS ASSOCIATED WITH A LIQUID-METALS HEAT TRANSFER SYSTEM. A. R. Hollins*, R. F. Saunders* and A. Robeson, Nuclear Engr. Program, Va. Polytechnic Inst., Blacksburg, Va. 24061

The recent decision by the U. S. Atomic Energy Commission to concentrate developmental efforts on the Liquid Metal Fast Breeder Reactor (LMFBR) has reemphasized the need for inclusion of liquid metals technology in engineering education. Demonstration sodium-cooled fast breeder nuclear power plants in the 300-megawatt (electric) range are projected for 1980 with the first 1000 megawatt unit scheduled to be operable by about 1985.

The repair and operation of a liquid metal heat transfer system* utilizing Nak at present, but readily adaptable to sodium, has been undertaken as a senior project at V.P.I. The project has included removing plugs of oxide and small quantities of Nak from the parts of the loop, complete rebuilding of the electromagnetic pump which had been severely damaged by a Nak fire and cleanup of available Nak for reuse in the system. A high temperature braze joint between the stainless steel pumping section and the massive copper secondary coil in the pump became a major problem because of heat losses in the copper. Use of a hydrogen-atmosphere furnace at ITT, Roanoke was necessary and cooperation of their staff is gratefully acknowledged.

Safety procedures for hauling Nak and sodium were an important part of the experience gained with the system.

* Manufactured by MSA Research Corp.

MOTIVATED DECISION TREE EXPLORATION USING TERMINAL ORIENTED HEURISTICS. Craig A. Decker, Jr.* Engineering Science, University of Virginia, Charlottesville, Va. 22902.

Theorem proving, game playing, and problem solving all have in common the need to be able to efficiently search large decision trees for desirable positions. Various heuristics have been applied to the basic minimaxing approach to reduce the number of nodes which must be searched. However, these traditional heuristic search methods lack a sense of direction or motivation toward a specific goal. This is primarily because the search is contiguous, moving from a current node only to adjacent nodes for further evaluation. This paper lays the foundation for noncontiguous search techniques which allow the program to first examine lower nodes for desirable positions and then orient itself toward reaching these goals on terminal positions.

Terminal oriented heuristics (T.O.H.) are shown to be superior to depth first and minimaxing search algorithms for solving maze problems, playing Nim games, and proving simple theorems in propositional calculus. (Research supported by Harry Diamond Laboratories and the University's Bureau on Educational Research).

THE DDT PROBLEM: AN ENGINEER'S APPRAISAL. J.A. Gideon and D. L. Michelsen, Dept. of Chem. Eng., Virginia Polytechnic Institute, Blacksburg, Virginia 24061.

Some uses, consequences and alternatives for DDT are discussed. Important uses of DDT include malaria control and control of pests on cotton. Consequences of DDT usage are unclear. Americans now carry 10 to 12 ppm of DDT in their body fat. The results of such long term, low level exposure are unknown. Effects on fish, birds and the ecology of various organisms are better documented. Alternatives to DDT include degradable pesticides and biological control methods. An integrated system is the most flexible mode of control. More work must be done on defining and evaluating the costs of various factors before economics can be realistically applied to pesticide usage.

CONCENTRATION RESPONSE OF FLOW LINES VIA PHOTOCHEMICAL PULSING. Thomas C. Hsu* and Otis L. Updike, Dept. of Chemical Engineering, Univ. of Va., Charlottesville, Va. 22901

A flash-photolysis technique has been used to introduce a color pulse into a simulated section of sampling line or tubular reactor as excitation for dynamics studies. Photosensitive solution flows at the desired rate down a Pyrex pipe, and intense radiation from a high-voltage annular quartz flashlight produces a slug of Turnbull's blue. This tracer is monitored colorimetrically as it passes an observation section, by absorption of a collimated light beam. Requiring no flow-splitting, this absorptiometer averages concentration over a transverse slice of fluid. An all-solid-state data logger provides high accuracy and rate of data collection, punching 3 decimal digits on paper tape for up to ten samples a second. The tape goes to a B5500 computer for processing; absorbance histories are numerically transformed into the frequency domain with the conventional Filon algorithm of pulse testing. The flow range studied included laminar, transition and turbulent regimes. A one-dimensional theoretical diffusion model, tested against the experimental frequency-domain response, represented turbulent data very well. When convective effects dominated, response was predictable and good out to high frequencies. Laminar data fitted this model, however, only in regions of low Reynolds number where molecular diffusions significant compared to convective effects; and high-frequency response is poor. Transition-range data were noisy and generally non-reproducible.

DEVELOPMENT OF A THEORETICAL ATTACK ON SLOPE STABILITY PROBLEMS. S. W. Hubbell¹ and J. H. Hunter². Dept. of Civil Engineering, Va. Polytechnic Inst., Blacksburg, Va. 24061

The ability of slopes to stand without failure is of interest in highway work, foundations, and earth and rockfill dams. The problem is one of economics and safety.

There are two approaches to the design and analysis of slopes. One is the empirical approach based on the experience of individual engineers with specific soils. The other approach, discussed in this paper, is a general solution based on theory. Several conditions, namely 1) potential failure surface shape, 2) strength and cohesion distributions, and 3) isotropic vs. anisotropic strength characteristics are discussed. The process of development of a generalized solution of the slope stability problem using reasonable assumptions based on present knowledge of these conditions is presented. Comparisons of the cohesion and strength assumptions of other writers in this field, such as Taylor, Gibson and Morgenstern, and Hunter are made.

A simple solution for slopes in normally consolidated clays with strength increasing linearly from a value equal to or greater than zero at the ground surface is presented.

Ongoing theoretical research by Hunter into the development of a generalized solution for anisotropic strength conditions is introduced. The method of approach is indicated which will, it is hoped, eventually make a practical solution possible. (Aided by NSF grant CZ1344)

ELECTROMAGNETIC CLUTCH PLATE WEAR. James J. Kauzlarich, John D. Pavlovsky, and Edward V. Mochel. Dept. of Mech. Eng., Univ. of Va., Charlottesville, Va. 22901

The theoretical wear behavior of multimaterial disk clutches and brakes, usually electromagnetically controlled, is presented. Design equations and criteria which are significantly influenced by wear are developed using Archard's Wear Law; including torque, axial wear rate, frictional heating, and material selection.

The results of the analyses show that the effects of wear, load, and heating, will be transferred to the material of lowest wear rate upon wear-in, making any high wear rate material ineffective. Since it is found that wear has a significant effect on multimaterial or single material clutch or brake performance, wear should not be neglected in design.

WIND LOADS ON OPEN TOP TANK FLOATING SURFACES. J. F. Marchman, III, Dept. of Aerospace Engineering, VPI, Blacksburg, Va. 24061

Wind tunnel tests were conducted on open tanks with varied inside surface levels. Pressure coefficient distributions are presented for the inside surface at several heights. Comparison is made with previous data on flat top cylinders and Reynolds number effects considered.

INTEGRATING MATRIX SOLUTION FOR THE NATURAL VIBRATION CHARACTERISTICS OF TWISTED, NONUNIFORM PROPELLERS. W. F. Hunter*. Flight Dynamics Section, NASA-Langley Research Center, Hampton, Va. 23665

A numerical method for determining the natural vibration characteristics of propeller blades is presented. Two coupled fourth-order differential equations having variable coefficients are given for describing the lateral motions of a rotating, twisted propeller blade which has a nonuniform and unsymmetrical cross section. A development of the integrating matrix, which is the basis of the method of solution, is given. The governing differential equations of motion are expressed in matrix notation. Utilizing the integrating matrix as an operator, and applying the boundary conditions, the differential equations are integrated and formulated into an eigenvalue problem. The solutions, which may be determined by various methods, define the natural vibration frequencies and the corresponding mode shapes. A numerical example is presented with the computed results being compared to experimental data. It is concluded that the equations of motion are applicable to typical propeller blades and that the method of solution yields accurate results. The use of the integrating matrix in solving other problems is discussed.

TRAFFIC SIGNAL WIND LOADINGS. J. F. Marchman, III, Dept. of Aerospace Engineering, VPI, Blacksburg, Va. 24061

Experimental results of wind loading tests on 15 configurations of standard "stop-light" traffic signals are presented. Both eight and twelve inch lens signals were tested in one, two, three and four light set combinations and with both standard and extended, full circular hoods. All of the tests were performed on free swinging lights and the signal was allowed to assume its natural orientation to the flow. The resulting wind loading data are plotted versus wind dynamic pressure. The effects of both damped and undamped oscillations of certain configurations are discussed, and suggestions are presented for further work to optimize traffic signal design.

FLUIDIC SYSTEMS FOR TEST SIGNAL GENERATION. David B. McCallum* and Otis L. Updike, Dept. of Chemical Engineering, Univ. of Va., Charlottesville, Va. 22901

Sinusoids, steps and ramps, pulses, and white noise are all used as excitation, though each has drawbacks, for characterizing dynamic systems. Pseudo-random binary sequences (PRBS) offer a new type of test signal with the advantages of pulses and white noise, yet fewer drawbacks. These signals are repetitive, over a long period; such deterministic stimuli eliminate the uncertainty of random excitation. Their spectrum is a dense "comb" of equi-spaced lines, and correlation techniques allow rejection of random noise between these line frequencies during reduction of response data. They are thus efficient stimuli, exciting the system over a broad band but requiring only small perturbation amplitudes and modest test duration. These virtues come at the cost of (a) additional computation and (b) a PRBS generator. The generator may be an on-line computer, or special-purpose hardware based on a shift register with feedback of a logical combination of the states of two or more stages. For process-type variables (pressure, flow, concentration, or temperature), a fluidic shift register is attractive in both speed and signal modality. A versatile fluidic generator has been constructed and used to confirm the superior properties of these test signals. This paper discusses some of the sequences, and indicates their application to instrumentation, process, and biomedical systems.

THE USE OF A FLUIDIC OSCILLATOR AS A MOLECULAR WEIGHT SENSOR. A. Smith, NASA Langley Research Center, Hampton, Va. 23365

Tests were performed utilizing ideal gases of a known composition to display their resonant frequency patterns as a function of pressure. All data was recorded at a constant temperature. It is shown that resonant frequency patterns are a function of a specific gas and the characteristic dimensions of the resonating cavity. Tests were performed using He, Ar, Ne, N₂, Air, CO₂, O₂ and a 50% mixture by volume of helium with argon and helium with carbon dioxide. Frequency response of the oscillator for a blowing pressure range from 0.5 to 68.9 × 10⁻³ newtons per square meter are presented along with a detailed description of the oscillator geometry, principle of operation and test apparatus. Data is presented to show a comparison between calculated and experimentally determined molecular weights of the gases tested. In addition, a section is included to display the fractional error associated with the experimental molecular weights determined. Tabulation of fractional errors between the theoretical and experimental values of molecular weights indicates an uncertainty of measurement in the range of 4.43 percent.

DESIGN OF AN ADVANCED HIGH SPEED TELEPRINTER.

J. K. Snell*, Manager, Data Communication Products Engineering Operation, General Electric Company, Waynesboro, Va. 22930

The General Electric TermiNet 300 Teleprinter was designed for higher speed and lower noise levels, to be used primarily for telephone line connection to large digital computers. The usual mechanical complexity of this type of machine was replaced with a large amount of electronics and a relatively simple mechanical structure.

To do this, many special materials problems were encountered, together with some rather interesting problems of dynamics. Most important of all was the reduction of volume and cost of the electronic circuits through the use of extremely large scale integrated circuits.

This development was the first in the General Electric Company, and one of the first in the world to commercially employ extremely large scale integrated circuits in significant numbers.

A TUNNELING SWITCHING CAPACITOR. T. J. Viola and R. J. Mattauch, Dept. of Elect. Engrg., Univ. of Va., Charlottesville, Va. 22901.

A new electron device consisting of a metal-oxide-metal system has been fabricated and tested. The small signal capacitance of the device switched values in a recoverable manner when the applied d.c. bias potential exceeded a certain critical value. The critical portion of the device, a metal-oxide-metal tunnel junction, has been found characterizable by the theoretical relations of Simmons. Design equations will be given and potential device applications discussed.

RELIABILITY TESTING - THE ARMY WAY. J. L. Wilson*, Mechanical Technology Dept., U.S. Army Mobility Equip. Research Ctr., Fort Belvoir, Va. 22060

This paper outlines the reliability test methodology, facilities and procedures utilized by the U.S. Army for testing self-contained environmental control units during the development process. The mathematical basis for the reliability calculations are outlined in general and specific terms using a recent test program as an example. Conclusions indicate that the additional costs involved in such a complex test program are justified.

EVALUATING AND RATING SLIPPERINESS OF PAVEMENTS. T. J. Yager², Landing and Impact Branch, Dynamic Loads Division, NASA Langley Research Center, Langley Station, Hampton, Virginia 23365

With increasing vehicle and aircraft traffic volume on highway and runway pavements every year, an accurate assessment and rating of pavement slipperiness, particularly for adverse weather conditions, is required to reduce accident rates and increase safety margins. In this regard, very promising results have been obtained with the measurement of the stopping distance of a diagonal-braked automobile. An excellent correlation of diagonal-braked automobile vs. aircraft stopping distance measurements is shown for several different slipperiness conditions on over 40 runway pavement surfaces tested.

Section of Geology

Forty-eighth Annual Meeting of The Virginia Academy of Science
May 6-8, 1970, Richmond, Virginia

GEOLIC WONDERS OF WASHINGTON CO., VIRGINIA: PRECAMBRIAN (?) BRACHIOPODS. C. S. Bartlett, Jr.* Dent. of Geology, Emory and Henry College, Emory, Virginia 24327.

Washington County, located in Southwestern Virginia, contains within its borders more than 32,000 feet of exposed Paleozoic sedimentary rocks and a few thousand feet of metamorphic and igneous rocks of late Precambrian age. Detailed mapping of the western part of the county during the past two years has outlined the extent of 32 mappable units from the Rome Formation of the lower Cambrian age to the upper Mississippian Pennington Formation. The total Mississippian section of nearly 6000 feet may be the maximum thickness in the eastern U. S. Many large thrusts were mapped including the 16,000-foot displacement Saltville Fault, the Pulaski-Staunton fault with about 5000 feet of displacement and the Bristol fault which is traced around three sides of Bristol.

In October, 1967, an important accidental discovery was made in the southeastern corner of the county of a well-preserved Limnoid brachiopod. Detailed search of the area has not resulted in the recovery of in-place specimens, but thin-sectioning and field study has proven that the fossil came from beds about 571 feet below the basal conglomerates of the lower Cambrian (?) Unicoi Formation, well within what has been mapped for many years as upper Precambrian Mount Rogers Volcanic Group. Stratigraphic correlation shows that this fossil bed is only a few feet above rhovelite recently dated at nearly 800 million years old.

SEISMICITY OF VIRGINIA
G. A. Bollinger, Dept. of Geological Sciences, V.P.I.,
Blacksburg, Virginia 24061

Earthquakes occurring in Virginia, and the bordering states of West Virginia and Maryland have been tabulated for the time period 1758 through 1968. Approximately 152 shocks are listed for this time period with the largest being the intensity VIII, Giles County, Virginia earthquake of May 31, 1897. The seismic activity for this region has averaged 12 shocks per decade since 1870, but unusually high annual activity is noted during 1897 and 1918. The spatial distribution of epicenters tends to form isolated "clusters" or "zones" in the western, central, and northern portions of Virginia. Forty-seven of the 60 earthquakes that have an assigned intensity were in the IV-VI range. Macroseismic surveys indicate an extreme variability in the amount of felt area associated with a given intensity event. A "halo" effect in the configuration of the felt region has been noted for some earthquakes. Earthquake sequences, probably aftershocks for the most part, have been reported in association with 22 earthquakes. Over one-third of all the earthquakes tabulated have reported subterranean sounds. (Supported by NSF Grant GA-1654)

THE ROLE OF THE MATHEMATICS AND SCIENCE CENTER IN EARTH SCIENCE EDUCATION. R. Wesley Batten, Mathematics and Science Center, 2200 Mountain Rd.. Glen Allen, Va. 23060

At the Mathematics and Science Center, emphasis on the earth sciences is applied at elementary, secondary and in-service levels through field-oriented programs. Local and state localities of geological interest are utilized with emphasis on local features and their relationship to the regional geology.

Teaching talent is drawn primarily from within the state and from all academic levels. Excellence in teaching is stressed.

Area-related courses in astronomy and oceanography are popular adjunct courses in the earth science programs at the Center.

In excess of 20 programs have been offered over a three-year period with a student-teacher involvement totaling more than 3,200. While the future presents many challenges, plans presently include the publication of field guides on the local level, development of practical earth science teaching kits, and regional coordination and counseling for students with interest in earth science.

GEOGRAPHICAL ONOMASTICS IN VIRGINIA AND ELSEWHERE.
R.L. Buchan * Library Director, Eastern Shore Branch of the University of Virginia and NASA Wallops Station, Wallops Island, Virginia 23337

The study of onomastic science and its major components is viewed as a background to geographical onomastics (toponymy). The bibliographic history of onomastics and geographical onomastics is reviewed as seen in International, American, and Virginian publications. The nature of geographical onomastics and the geological significance of geographical onomastics is presented, followed by a review of current place name activities in Virginia including the activity of the Virginia Place Name Society.

JOINTING AND FOLIATION IN PETERSBURG GRANITE NEAR RICHMOND,
M.E. Campana*, Dept. of Geology, Col. of William and Mary,
Williamsburg, Va., 23185

A total of 835 joints were measured from five localities in the Petersburg granite. Three localities along the James River at Lee Bridge, Maymont Park, and Huguenot Bridge, lie in a line normal to the length of the pluton. The fourth locality is at the falls of the Appomattox River in Petersburg and the fifth, north of Midlothian, is near the western margin of the pluton. 360 measurements of foliation were made at the James River localities. A total of 285 joints in the adjacent gneissic host rock were measured from exposures at Rawlings, Genito, and Sabot.

A major joint set striking N55°-65° and dipping very steeply dominates the Huguenot, Lee, Petersburg, Genito, and Sabot exposures. Although the dominant joint sets at Maymont, Midlothian, and Rawlings are somewhat divergent, all strike to the NE and dip steeply SE. Foliation in all three James River localities is nearly identical, with average attitudes of N20°-35°E, 55°-75°SE.

Similarity of joint sets in the Petersburg granite and in the gneiss suggests that jointing in both was contemporaneous and was due to stress after emplacement of the Petersburg. Uniform foliation within the Petersburg also suggests deformation of the granite after its emplacement. The divergent jointing at Maymont and Midlothian may be due to the anomalous very coarse texture of the rocks at these two localities. (Aided by NSF grant GL-5942)

A FLAME PHOTOMETRIC DETERMINATION OF Ca-Mg PERCENTAGES IN COQUINA-COQUINITE FACIES OF YORKTOWN FORMATION NEAR CHUCKATUCK, VA., J. E. Cole*, Dept. of Geology, Col. of William and Mary, Williamsburg, Va., 23185.

Calcium and magnesium percentages have been determined using flame photometric methods for samples of coquina and coquinite from the Yorktown Formation at the Lone Star Cement Company pits near Chuckatuck, Va. Coquinite samples were collected from water level to 5' and coquina samples were taken from 5' to 8'. Above the coquina was a two foot thick clay bed. Twenty-four sets of samples were analyzed from the sequence yielding percentages between 95.5 and 94.0 for calcium and between 0.5 and 2.5 for magnesium. The calcium-magnesium ratio decreases upward in the sequence. The coefficient of correlation between calcium and magnesium percentages was -0.4082. This slight correlation may result from differential solution of carbonates above the groundwater table and the precipitation of the carbonates at or near the groundwater level. The higher percentages of calcium observed in the coquinite is attributed to the difference between the solubility products of calcium carbonate and magnesium carbonate.

PETROLOGY OF METAMORPHUSED VOLCANIC ROCKS NEAR HYLAS,
VIRGINIA, S. C. Clement, Dept. of Geology, Col. of William and Mary, Williamsburg, Va., 23185

Volcanic and sedimentary rocks exposed in the Royal Stone and Rockville quarries, located near Hylas, approximately 15 miles northwest of Richmond, have been metamorphosed into thinly laminated grayish green phyllites and phyllitic schists with intercalated quartzose layers. The essential minerals of the phyllite are quartz, plagioclase, epidote, chlorite, biotite, sphene and opaques. The essential minerals of the quartzose layers are quartz and potash feldspar with minor amounts of plagioclase, biotite, muscovite, epidote, garnet and opaques. The quartzose layers, always parallel to the laminations of the phyllite, are up to six inches thick and commonly can be traced for several hundred feet. The mineral grains average 0.05 mm in diameter and exhibit closely spaced banding parallel to the contacts. Parallel strings of rounded, equal-sized garnets are associated with opaque minerals and suggest a detrital source and sedimentary origin for the quartzose layers. The phyllite contains numerous subdrilled to anhedral complexly twinned and strongly zoned plagioclase grains of intermediate composition suggestive of an igneous origin. It is proposed that the phyllitic rocks, now metamorphosed to the quartz-albite-epidote-biotite subsurfaces of the greenschist facies, originated at least in part as pyroclastic accumulations of quartz latite or dacite. These accumulations could have been water-laid and intercalated with quartz-rich silt-sized sediments.

GEOSCIENCES AT THE SMITHSONIAN INSTITUTION. F. J. Collier,
Dept. of Paleobiology, U. S. National Museum of Natural
History, Washington, D. C. 20560

The Smithsonian geologic community is composed of more than 35 members of the Museum research faculty with a slightly larger supporting and collection management staff, plus an equal number of Federal Survey paleontologists. Activities are divided into three categories; collection care, research and education. Assets include the largest and most complete systematic collections of fossils, rocks and minerals in the western hemisphere; world wide programs in basic paleobiological and mineral sciences research; and increasing facilities for graduate education including fellowships for pre-and post-doctoral research. The most complete known representation of Virginia geological materials has resulted from students and researchers using the Museum as a repository while cooperative programs have Smithsonian people continually on field projects in Virginia.

MINERALOGY OF THE PETERSBURG GRANITE EXPOSED IN THE TIDE-WATER STONE QUARRY, RICHMOND, VA. C. D. Condit*, Dept. of Geology, Col. of William and Mary, Williamsburg, Va., 23185

On the basis of modal analysis of thin sections cut from samples collected in the Tide-water Stone quarry, two major igneous rock units have been defined. The oldest rock exposed is a tonalite that is composed of plagioclase feldspar of intermediate composition, hornblende, biotite and quartz with minor amounts of opaques, sphene, apatite and potash feldspar. The tonalite has been intruded and locally thermally metamorphosed by quartz monzonite that is composed of approximately equal proportions of quartz, potash feldspar and plagioclase with minor muscovite, apatite, sphene and opaques. Because the contact between the two rock units is sharp, the sequence of intrusion has been determined by the presence of scattered areas of recrystallized tonalite that contain large crystals of biotite, hornblende and clouded plagioclase and abundant apatite and sphene. The quartz monzonite was emplaced as a multiple intrusion for light gray quartz monzonite cuts medium gray quartz monzonite. Numerous dikes of aplite and pegmatite intrude the tonalite and quartz monzonite. Both the tonalite and the quartz monzonite have been metamorphosed to the greenschist facies.

A PRELIMINARY STUDY OF MINERALOGIC TRENDS IN A PORTION OF THE PETERSBURG GRANITE, RICHMOND. N. Dickey*, Dept. of Geology, Col. of William and Mary, Williamsburg, Va., 23185

In an attempt to determine the mineralogic variability and compositional trends within a limited portion of the supposedly uniform Petersburg granite, modal analyses were made on discs of drill cores taken along a strip approximately three miles in length that extends northward from the south bank of the James River near the Richmond-Chesterfield County boundary parallel to the Richmond, Fredericksburg and Potomac Railroad right-of-way. Samples were stained with cobaltinitrite and rhodizonate to differentiate potash from plagioclase feldspars under reflected light. When plotted on a quartz-potash feldspar-plagioclase triangle, the modal compositions outline an elliptical area in which a concentration of compositions is centered within the quartz-monzonite field. The ellipse, however, contains many samples within the granodiorite field. The average composition of the highly concentrated cluster is: quartz-28%, plagioclase-38%, potash feldspar-34%. Although mineralogically the Petersburg granite in the area studied is dominantly quartz monzonite, individual samples may be quite variable. At several sample locations, drill cores taken from within several hundred feet of each other vary by only a few percent in composition, while at other sites, compositions range from granodiorite to quartz monzonite within a few feet of drill core. (Aided by NSF grant GL-5842)

THE ROLE OF THE GEOLOGIST IN VIRGINIA'S HIGHWAY PROGRAM.
W. E. Dvorak, Jr., Geology Section, Va. Dept. of Highways,
Richmond, Va. 23219

Virginia's accelerated road building program, triggered by the Interstate System, dictated the need for geologists. Procurement of data for geologic conditions and engineering characteristics for structures, soils, cut-slopes, and materials are within the realm of the geologist's responsibilities. Preventive or corrective measures for landslides are outlined, as well as investigations for damage claims resulting from construction operations. Geologic studies are conducted well in advance of actual construction in an effort to eliminate or minimize detrimental effects to either the proposed roadway or its contiguous environment.

THE INPUT OF ENVIRONMENTAL GEOLOGY TO LAND USE AND URBAN DESIGN IN THE GAINSBORO COMMUNITY, ROANOKE, VIRGINIA.
T. A. Dumper* and J. O. Waller*, Dept. of Geological Sciences, Virginia Polytechnic Institute, Blacksburg, Virginia 24061

The physical environment of Gainsboro Community, Roanoke, Virginia was identified through environmental geology studies of its physiography, materials framework, areal dynamics, and climate components to provide information to graduate-student planners and designers at Virginia Polytechnic Institute. The interaction of topography and geology was demonstrated through the relation of characteristic linear hills developed on rocks of the Rome Formation to the underlying geologic structure. Properties of soil and rock materials pertaining to construction were identified and discussed relative to foundation strength, ease of excavation, and suitability for use as fill. The influence of geology and topography were reflected in the design and quality of housing relative to topographic location and the placement of streets and highways. The Washington Park section of the community was used as a model to demonstrate how opportunities and constraints of the physical environment affect urban design and land use. This area contains schools, an abandoned landfill that constrains residential development, and a neighborhood park which would form the nucleus of a large recreational development.

GEOLOGY IN THE COMMUNITY COLLEGE. John W. Funkhouser, Dept. of Science, John Tyler Cmnty. Col., Chester, Va. 23831

Geology is being offered in only two community colleges in the Va. system. These are Va. Western in Roanoke and John Tyler in Chester. This is its fourth year for Va. Western, its first for John Tyler.

So far only first-year geology is offered, and most students take it as a science elective. However, several geology majors have come out of the program; also it is considered a "must" course by most ecology majors.

The enthusiastic student reception in both schools, plus public interest, suggests that wider adoption within the system is warranted.

THE SIGNIFICANCE OF IRON SULFIDES IN SEDIMENTS.
John W. Funkhouser, Dept. of Science, John Tyler Cmnty. Col., Chester, Va. 23831

In dark marine shales much of the dark color, often attributed to high organic content, actually results from micro-crystals of iron sulfide, usually pyrite. The abundance of these crystals, as well as their crystal forms, appears to be directly related to the amount and "state" of the solid organic matter present. It is further suggested that complex interactions among iron, sulfur, and organic materials could account for hydrocarbon production.

SPECIES DIVERSITY IN STATISTICAL STRATIGRAPHIC ANALYSIS. D. L. Gates*, Dept. of Geology, Col. of William and Mary Williamsburg, Va. 23185

Previous studies (Beerbower and Jordan, 1969) have shown that paleoenvironmental boundaries can be delineated by the application of information theory in detailed biostratigraphic studies. However, difficulties arising from the application of information theory to apparently faunally and lithologically homogeneous units limit its use in stratigraphic analysis.

The information theory method relies on the statistical mean of the probability of occurrence of taxa from predetermined groups of samples. This method is related to the proposed chi squared method, which allows direct comparison of samples on the basis of frequency of occurrence of taxa; both are statistical methods used to differentiate paleoenvironments. Studies using both techniques, involving gastropods from the Peoria Loess in southwestern Indiana and mollusks from the Yorktown Fm. in southeastern Virginia, indicate that information theory tends to obscure zones of paleoecologic significance due to overall outcrop similarities and a random sampling pattern. The chi squared method, although restricted in application, was not affected by the sampling pattern. Further, the chi squared method can differentiate fossil zones in an outcrop of undetermined paleoecologic parameters. Thus the chi squared method is supplementary to information theory, allowing it to be applied to achieve maximum effectiveness in determining paleoenvironmental boundaries in a stratigraphic sequence.

TECTONIC ERRATICS NEAR CHRISTIANSBURG, VIRGINIA.

F. R. Glass, Jr.* and W. D. Lowry, Dept. of Geological Sciences, V.P.I., Blacksburg, Virginia 24061

Numerous erratic blocks of quartzite and siliceous dolomite up to several feet across occur at two localities southwest of Christiansburg, Virginia. The erratics probably represent the basal sandstone and somewhat younger dolomite of the Upper Cambrian Copper Ridge Formation. Those atop and north of the ridge south of the County Fairgrounds rest on middle and upper members of the formation, which here forms the south limb of the Christiansburg anticlinorium. The erratics, some highly fractured, were plucked from farther down this south limb by the Pulaski thrust, whose trace lies 0.25 mile south of the ridge crest.

Nearly identical and more numerous erratics occur south of Interstate 81 and west of Virginia Route 8. They rest on a belt of Elbrook(?) carbonates which separates a half-klippe of Rome shale on the north from the Rome of the main Max Meadows thrust sheet to the south. Presumably, all erratics have a common root. If so, it appears that the far-travelling Pulaski sheet first plucked off part of the Copper Ridge and then the Max Meadows thrust sheet plucked off more as it moved up over the terminus of the Pulaski sheet.

THE GEOMORPHOLOGY OF FIRE ISLAND, NEW YORK.
Robert C. Glassen*, Department of Environmental Sciences, University of Virginia, Charlottesville, Va. 22903.

Fire Island, New York, is perhaps best described as a large well-developed sand spit rather than a true barrier beach. It was formed by different processes than nearby Jones Beach, which is a true barrier island. As a sand spit, Fire Island must follow its major source of sediment and migrate to the north. If the beach were in a natural state, migration would occur by blowover and washover, with progradation on the bay side, and degradation on the ocean side. At the present time, dense housing, high artificial dunes, and bulkheading on the bay side prevent natural migration from taking place.

GEOLOGICAL ENDEAVOURS OF VIRGINIA'S COLLEGES AND UNIVERSITIES.
B. K. Goodwin, Dept. of Geology, Col. of William and Mary, Williamsburg, Va. 23185

Eight institutions of higher education in Virginia offer the baccalaureate in geology or geologically oriented programs. Of these, three have programs leading to the Master of Science and one confers the Doctor of Philosophy in geology. Together, the eight institutions have a combined geology or related faculty of 52, have a total of about 230 undergraduate major students, 60 candidates for the MS, and 27 students working toward the PhD. Institutions engaged entirely in undergraduate geology programs are The College of William and Mary, Madison College, Mary Washington College, Old Dominion University, and Washington and Lee University. The University of Virginia and Virginia State College also offer the MS in Environmental Science and Earth Science respectively. Virginia Polytechnic Institute has a complete program encompassing the AB, MS, and PhD degrees.

Most of the geology faculty members are actively engaged in research. Although some research is on theoretical studies, global problems, and other areas of the United States, the major emphasis is on the geology of Virginia. These institutions are also continually striving to mold their programs in order to best serve the needs of their students and of society. New programs in environmental science and earth science education attest to this effort.

A GENERAL METHODOLOGY FOR ANALYSIS OF PHYSICAL FACTORS IN ENVIRONMENTAL PLANNING.
James E. Hackett*, Dept. Geological Sciences, Virginia Polytechnic Institute, Blacksburg, Virginia 24061.

Increased pressures on the environment can be anticipated as a consequence of growing population, expanding urbanization and rapid technological change. At the urban and regional scales of development, environmental planning must deal with the complex interactions between man, society and the natural physical system. Environmental planning as a total activity requires the organized input of effort from several sources and lines of communication among the disciplinary and professional areas must be established.

The analysis, evaluation and application of physical factors for environmental planning requires a systematic process of study wherein all basic components of the physical environment are considered in an integrated manner in terms of their influence on area development. The basic steps of the process are: (1) System Definition, (2) Resource Analysis, and (3) Use Capability Analysis.

PETROGRAPHY AND INTERPRETATIONS OF SELECTED MIDDLE ORDOVICIAN LIMESTONES OF SOUTHWESTERN VIRGINIA. A. W. Hayes*, H. C. Ganow†, and G. C. Grender. Dept. of Geol. Sci., V.P.I., Blacksburg, Virginia 24061

Preliminary petrographic study of five Champlainian (Ordo-vician) limestones in SW Virginia indicates cyclic sedimentation, and suggests that some dolomitization may be related to alteration of montmorillonite to illite.

Cyclicity is most evident on a micrite-spilitite-allochem trilemma diagram (Folk, 1959). The cycle begins with Elwy (biomicrite - intraclastic biomicrudite; low energy; lacustrine?), and continues with Five Oaks (slightly fossiliferous dolomitic; low energy), Lincolnshire (intraclastic biosparudite; moderately high energy), lower Pearisburg and Ward Cove (petrographically similar fossiliferous intra-sparudites; fairly high energy; inlet? fore-reef?), and returns to quiet Elwy conditions with upper Pearisburg and Peery (petrographically similar biopelmicrites). Preliminary field work suggests a continuation of the cycle in the overlying Benbalt, Graton, and Witten Limestones.

Dolomitization occurs in clayey zones which are sometimes stylolitic. The close association between dolomite and clay leads to the speculation that dolomitization may take place through release of Mg by montmorillonite during alteration to illite. This tentative conclusion is supported by x-ray analysis, staining, and plots of insoluble residues vs. dolomite content.

THE PROFESSIONAL GEOLOGIST. A. U. Honkala, Consulting Geologist, Richmond, Va.

The professional geologist is finally more than just a symbolic classification; he is a reality. Tracing the growth and responsibility of a profession is the purpose of this paper. The realization that geologists are deeply involved in the future of our country has only reached the public eye in recent years with the advent of such events as the great Arctic oil search, the moon race, the urban problems of California, the Mohole Project, and others. It is the geologist's responsibility to establish a professional attitude about his relationship to his fellowman, and to create, by proper controls, a service that can be utilized, understood, and depended upon by the community that he serves.

SEISMIC STUDIES OF THE VIRGINIA EARTHQUAKES OF 20 NOVEMBER AND 11 DECEMBER, 1969. Margaret Hopper* and G. A. Bollinger, Dept. of Geological Sciences, V.P.I., Blacksburg, Va. 24061

On November 20, 1969, an earthquake occurred near Elgood, W. Va., just north of the Virginia-West Virginia border, and on December 11, 1969, another earthquake, this one in the central Virginia area north of Richmond, was felt. Microseismic and macroseismic studies were made for these shocks.

Arrival times of the seismic vibrations at 24 regional seismographic stations were recorded for the Elgood earthquake. From these data the epicenter was calculated as $37.4^{\circ}\text{N}-81.0^{\circ}\text{W}$, and the origin time as 01:00:10.3 GMT. A magnitude of 4.3 was determined from the records of six regional stations. A microaftershock survey was conducted in the epicentral area for three days, and five definite and four possible microaftershocks were recorded. Macroseismic data were gathered by 50 mailed questionnaires and by field surveys. These data indicated a maximum intensity (MM) of V and a felt region of 125,000 square miles over nine Mid-Atlantic states.

The central Virginia earthquake was much smaller (magnitude of 3.5) than the Elgood tremor. Epicentral location and origin time were calculated using data from six stations. Results of a questionnaire survey indicated a maximum intensity (MM) of IV and a felt area of 6000-6500 square miles in central Virginia. Also, a possible "halo" effect was implied by several isolated felt reports. (NSF Grant GA-1654)

THE NATURE OF THE CLASSICAL CONTACT OF THE ST. MARYS AND YORKTOWN FORMATIONS ON THE SOUTH BANK OF THE JAMES RIVER IN VIRGINIA.
W.G. Huber, Dept. of Environmental Sciences,
University of Virginia, Charlottesville, Va. 22903.

The contact of the St. Marys and Yorktown formations was defined by Mansfield on the basis of the faunas and described as unconformable. While more recent workers have interpreted the contact to be conformable, current data support the original theory. These data consist of 1) a major faunal difference between the two units, 2) a lag of bones and teeth on the contact, 3) angular discordance of the formations, 4) lack of intertonguing faunal relationships while intertonguing is common within the Yorktown formation, 5) an abrupt contact between the two formations, 6) reworking of the St. Marys fauna, 7) undulatory contact of the formations locally with flatter beds above and below, and 8) pinching out of the lower zone of the Yorktown.

MINERALOGY OF A PERRIERITE-BEARING PEGMATITE NEAR CHAMBLISSBURG, BEDFORD COUNTY, VIRGINIA.
D. E. Lowenhaupt*, G. L. Mozingo*, and R. S. Mitchell. Dept. of Environmental Sciences, Univ. of Va., Charlottesville, Va. 22903.

Recent studies, by one of the writers (RSM), have shown that museum specimens of chevkinite reported from an unspecified locality in Bedford County in 1891 are actually perrierite. Identical material has recently been found in the same country in an old pit on the farm of W. E. Dooley, about 1/2 miles north of Chamblissburg off State Road 616. The deposit is possibly where the original Bedford County "chevkinite" was collected. The black perrierite masses, up to 5 inches across, generally have alteration rinds of brown earthy anatase. Secondary bassetsite and monazite-like crusts are also associated with these masses. Other minerals identified from this old weathered deposit are microcline, Na-plagioclase, gray quartz, black amphibole, apatite, zircon, magnetite, and ilmenite.

ANTIQUITY OF MAN IN VIRGINIA. H.A. MacCord, Sr.,
Virginia State Library, Richmond, Va. 23219.

Archaeological evidence of man in Virginia since about 8000 BC has been found and cross-dated by finds in other states and by radio-carbon dating. The evidence is mostly stone tools of unique types. One workshop of the earliest (Paleo-) Indians is known in Dinwiddie County, and others are sought. Since Paleo-Indians hunted animals which became extinct (mammoths, ground sloths, horses, and others), studies of post-Pleistocene bone deposits may be expected to yield traces of human activity. The early Indians were nomadic hunters and gatherers who left traces all over the state. Following extinction of the mammoth, more intense exploitation of small game and vegetal foods became necessary. About 1000 BC, introduction of pottery and agriculture changed Indian behavior patterns and led to the cultural status found by Europeans in the 16th Century.

Numerous sites of Indian activity have been excavated in Virginia, yielding data on subsistence patterns, community plans, tool technology, art forms, and burial customs. Detailed study of skeletons provide data on individual size, appearance, pathologies, death-rates, and so on. Most data available pertains to later Indians only, and many gaps exist in our knowledge of the earlier peoples. Increased emphasis on dating animal extinctions, riverine terraces, and similar recent developments in geology is urged.

THE URBANIZATION OF THE GREEN COVE DRAINAGE BASIN, WILLIAMSBURG, VIRGINIA. J.F. Maloney*, C.E. Turner*, and G.H. Johnson. Dept. of Geology, College of William and Mary, Williamsburg, Virginia 23185.

Green Cove, the eastern branch of Lake Powell, is connected to the main body of the lake through a breached dam. The cove is an arcuate body of water 0.3 mile long, approximately 100 feet wide, and 8 feet deep near the dam. The cove is shallower than adjacent parts of Lake Powell. The area of the drainage basin is approximately one square mile.

Before 1950 little development had taken place in the drainage basin. By 1970 nearly one half of the basin had been developed for single and multiple family dwellings. An influx of inorganic sediments from this development has resulted in the formation of a major delta complex in the upper reaches of the lake, a decrease in the organic content of the sediments, and a shallowing of the water in the cove. Changes in bottom sediments and morphology of the lake basin indicate that poor development practices within the drainage basin are contributing to the premature demise of Green Cove.

AMERICAN INSTITUTE OF MINING, METALLURGICAL, AND PETROLEUM ENGINEERS. Wilson D. Michell,
Reynolds Metals Co., Richmond, Va. 23218

The aims and activities of the Institute in behalf of the minerals industry are discussed with particular reference to the role of professional geologists in the organization. Of the three constituent societies - The Society of Mining Engineers, The Metallurgical Society, and The Society of Petroleum Engineers - emphasis is given to the first named, in which a relatively large number of geologist members are active.

Geologists who, through scientific training, inclination, and experience, have directed their efforts to the exploration for and development of the earth's mineral resources find in the Institute a valuable association with other scientists, mineral engineers, and educators. Within this association the geologist can make a useful contribution to scientific knowledge, to the advancement of his profession, and to society in general.

RECENT GEOLOGIC WORK IN LEE AND WISE COUNTIES. R.L. Miller.
U.S. Geol. Survey, Washington, D.C. 20242

Lee and Wise Counties lie entirely within the Cumberland Overthrust Block, a unique structural feature in the Southern Appalachians. Because of its important coal deposits in rocks of Pennsylvanian age, and oil and gas potential in rocks of Mississippian and Ordovician age, much of the Cumberland Block in Va. has been mapped at the scale of 1 to 25,000. In different parts of the block, the position of the Pine Mountain Overthrust Fault underlying the block is now known to be at four different stratigraphic horizons, ranging from Lower Cambrian to Upper Devonian. The places where the fault plane cuts across from a lower to a higher stratigraphic horizon are known in some parts of the block and can be deduced with considerable assurance in some other parts.

Complex folding and faulting within the block is common in rocks of pre-Mississippian age in Va. but rare in the overlying Mississippian and Pennsylvanian rocks. Deep drilling in the Rose Hill Oil Field has revealed an unexposed major fault beneath the Pine Mountain Fault, which is probably a branch of that fault. Recent reconnaissance mapping at the northeast end of Powell Valley in Wise County has revealed another strongly disturbed zone, whose relation to the Pine Mountain Fault has yet to be determined.

PROCEDURE FOR DEVELOPING A SUB-SURFACE WATER SUPPLY.
Robert R. Peters, P.E.*^{*}, Lane-Atlantic Company, Norfolk,
Va. 23509

Method for developing a sub-surface water supply would be initial research of all available data on area. After this, test drilling to a depth penetrating available water strata; collecting formation samples of each strata; conducting a geophysical log of the bore hole; pumping water samples in unknown areas; installing of casing, well screen and cementing procedures; installation of test pumping equipment to ascertain production and water levels; and installation of observation wells to determine hydraulic characteristics of formation. This enables overall productivity of area together with proper well spacing.

PLINTHITE - A NEW GENETIC HORIZON FOR COASTAL PLAIN SOILS IN VIRGINIA. D. E. Petty and J. H. Elder. Dept. of Agronomy, Va. Polytechnic Inst., Blacksburg, Va. 24061

Plinthite is defined as a sesquioxide rich, humus poor, highly weathered mixture of clay, quartz, and other minerals. It usually occurs as red mottles in a reticulate pattern that forms a continuous phase in a pedogenic soil horizon. Plinthite has not been recognized previously in Virginia. It is normally associated with the highly leached soils of the tropics and sub-tropical areas. Specimens from Spotsylvania, Hanover, and Chesterfield Counties were investigated in this study.

X-ray and differential thermal analyses indicated the clay fraction of the plinthite was dominantly kaolinite, gibbsite, intergrade vermiculite, and quartz. The silt and sand fractions were dominated by quartz. Chemical analyses indicated the plinthite had low exchangeable base content, low cation exchange capacity and it contained segregated iron and aluminum oxides in the mottles. Microscopic examinations revealed the pedds had a continuous coating of oxides which linked the particles together.

Morphological investigations and laboratory analyses indicated the material meets the criteria established for plinthite in the current soil classification system. Field studies indicated plinthite may be extensive in the soils of several Coastal Plain counties of Virginia.

THE SOIL SURVEY AND INTERPRETATION PROGRAM IN VIRGINIA. D. E. Petty and W. J. Meyer. Dept. of Agronomy, Va. Polytechnic Inst., Blacksburg, Va. 24061.

The soil survey program in Virginia is a cooperative endeavor between the V.P.I. Research Division-Department of Agronomy, the U. S. Dept. of Agriculture, and the participating counties. Although soil surveys have been in progress over 60 years, only about 9 million of the 25-1/2 million acres in Virginia have detailed soils information. Detailed soil surveys provide an inventory of one of our most valuable natural resources. Soils produce the food and fibre products and the environment that sustain life as we know it on earth.

A new soil classification system called the 7th Approximation was adopted nationally in the mid 1960's. A completely new vocabulary and expanded classification categories were introduced in this system. The new system was designed to utilize new advances made in technology and other fields of soil science.

Rapid urban expansion has accelerated the need for detailed soil surveys and soil interpretation. Soil scientists of the Agronomy Department, V.P.I. work full time in soil interpretation programs in Loudoun, Prince William, and Chesterfield Counties. One soil scientist of the Agronomy Department is attached to the State Health Dept. as a liaison between soils and environmental health.

A GROUND-WATER PROGRAM FOR VIRGINIA. E. W. Ramsey. Va. Div. of Water Resources, Dept. of Conservation and Economic Development, Richmond, Va. 23219.

Increased demand for information on occurrence, distribution, protection and development of ground water has led to initiation of a program of investigation to collect basic quantitative and qualitative data and develop modern skills essential to its optimum utilization. The observation well project includes 28 wells, geophysically logged, with automatic level recorders. Additional observation wells and geophysical logging of key wells are scheduled. Quality-of-water sampling and analysis and an annual inventory of ground-water use, wells and springs are projects, as are aquifer pumping tests, occurrence of high-chloride water in Coastal Plain aquifers, aquifer protection and geohydrologic reports on river basins. A special project is data handling by accurate collection, verification, reduction to Fortran, and punching on computer cards to enable sorting, computations and mapping by x-y plotter. Consultation and service are provided ground-water users and liaison is maintained with water-well contractors and with State agencies and with the U. S. Geological Survey, Water Resources Division in a cooperative program for investigation of water resources. A geohydrologic map of Virginia is planned. Eight geologist positions are authorized.

GROUND-WATER QUALITY AND STRUCTURAL CONTROL IN SOUTHEASTERN VIRGINIA. W. S. Rogers, R. S. Spencer. Dept. of Geophysical Sciences, Old Dominion University, Norfolk, Va. 23508

Investigations into the stratigraphy, structure, chloride concentrations and piezometric surfaces of the York-James peninsula and adjacent Coastal Plain areas to the south indicate that these factors are intimately associated with each other. North-south e-log correlations across the area support the proposed Hampton Roads fault in the vicinity of the James River. Isohaline contours trend subparallel to the James River in the York-James peninsula and piezometric surfaces show a marked dissimilarity on either side of this geographic boundary. The high chloride concentrations in this area plus the disruption of the ground-water system imply fault control and incursions of saline waters along the Hampton Roads fault zone during times of recurrent movement. A similar situation exists near the confluence of the James River with the Chesapeake Bay. A disrupted piezometric surface and high chloride zone are found in conjunction with a proposed north to northwesterly trending fault zone the Norfolk Hinge. Highest chloride concentrations, greatest disruption of the piezometric surface, and greatest stratigraphic displacement occur near the intersection of these two faults. (Aided by Union Camp Corp. Grant)

MINERAL-WATER EQUILIBRIA IN SELECTED VIRGINIA STREAMS. W.C. Sherwood. Department of Environmental Sciences, University of Virginia, Charlottesville, Virginia, 22903.

Chemical analyses of selected stream waters draining silicate rocks of the Virginia Piedmont were compared with analyses of selected streams draining largely carbonate terrane in the Valley and Ridge to the west. Plotting the log of activities of dissolved SiO_2 vs the log of the ratio of Na^+ over H^+ showed that the Piedmont waters fell well within the kaolinite stability field but some samples showed low SiO_2 activities and fell in the gibbsite stability field.

Discharge vs concentration for selected dissolved ions in streams draining both silicate and carbonate areas was also investigated. Ca^{2+} , Mg^{2+} , and HCO_3^- concentrations were approximately an order of magnitude greater in the latter. The ranges for Na^+ and K^+ were similar for the streams draining each rock type except in the case of the Rivanna where higher concentrations of each element are explained by pollution effects. In each case the ionic concentration showed an inverse, and exponential relationship with discharge. Na^+ and K^+ concentrations at maximum (flood) discharge conditions approached a minimum comparable to that expected from rain water contribution alone.

CURRENT STATUS OF EARTH SCIENCES. Ross L. Shipman,
Astt. Exec. Dir., American Geological Institute, Washington, D.C.

Apollo 13 was to have been a voyage for science. In the aborted mission we lost the opportunity for two geology field trips. Moon exploration had been proceeding at a much more rapid pace than sound scientific applications would desire. Perhaps the technological slowdown will be a scientific boon.

The JOIDES deep-sea drilling program has tended to confirm the magnetic-linear relationship between the age of the oldest recovered sediments and their distance from the axis of a mid-oceanic ridge.

For decades we considered Earth a planet whose crust was essentially rigid, disturbed only by local effects and some vertical adjustments. Now we view the upper layer of the earth as a mobile, everchanging system.

The standard of living that industrialized nations have achieved and that other nations are working to attain is based upon the development of mineral resources; our society could not continue in its present state without them. However, there is a public fear that the exploitation of minerals and mineral fuels is damaging the environment to an extent that is not only reducing the quality of life but eventually may make the earth unsuitable for human habitation. Drastic reduction in mineral production and consumption would bring about a major decrease in our standard of living. Mineral resource processing is such a large activity that it must have public consent. If the production and consumption of mineral resources are opposed to either equally or more important values, the public must choose between them.

The current status of Earth sciences? This is truly the "golden age."

HYDROLOGIC INPUT TO LAND USE AND URBAN DESIGN IN THE GAINSBORO COMMUNITY, ROANOKE, VIRGINIA. J. O. Waller* and T. A. Dumper*, Dept. of Geological Sciences, and E. P. Zeisel*, Dept. of Civil Engineering, Virginia Polytechnic Institute, Blacksburg, Va. 24061

An environmental approach for evaluation of ground-water and surface-water resources and watershed characteristics in relation to land use and urban design was applied to the Gainsboro Community, Roanoke, Virginia. Two major urban hydrologic problems, flooding and water quality, were evaluated for Trout Run and Lick Run. Future flooding could be reduced by removal of constrictive channel enclosures, enlargement of open channels, and relief of constrictions under the Norfolk and Western Railroad tracks. Poor water quality is related to storm-water runoff, channel debris, sewer relief points, the Washington Park landfill, septic fields, and construction activity. Parks along Trout Run near Moorman Avenue and Lick Run opposite the Roanoke Civic Center were proposed to use land constrained by susceptibility to flooding. The effect of future urbanization on runoff from the Lick Run watershed was also studied. This environmental approach can be applied to other urban areas to identify environmental opportunities for community development in harmony with environmental constraints.

ELECTRON MICROSCOPY OF WEATHERED QUARTZ GRAIN SURFACES, PLEISTOCENE(?) SEDIMENTS OF YORK-JAMES PENINSULA. P. B. Wendell*, Dept. of Geology, College of William and Mary, Williamsburg, Va., 23185

A problem of Coastal Plain geology is differentiation between "terrace" formations by conventional geologic methods. Experimentally reproducible features related to diagenesis are present on many quartz grains (Krinsley and Donahue, G.S. A. Bull., 1968). Because "terrace" formations have been exposed to weathering for differing durations, the frequency of diagenetic markings on the quartz grains of the formations might be indicative of the weathering interval. If so, frequencies of grain-surface weathering features could be used to determine relative ages of "terrace" formations.

A pilot test of this hypothesis used samples from one outcrop of Windsor Formation (Yarmouth? age) and one of Norfolk Formation (Sangamon? age). Analysis of variance (χ^2 -level nested model) was performed on grains selected randomly from samples of the leached A soil horizon. A reported diagenetic marking is a groove in the grain surface along which occur irregularly spaced "holes" (also found elsewhere on the grain). Procedure was to count "holes" within a randomly selected area. Thirty-two counts were made, two counts on each of two photographs from different parts of each of four grains from each formation. The analysis confirms that the technique successfully differentiates the Windsor and Norfolk Formations. The hypothesis of uniformity between outcrops of the same formation remains to be tested before the technique can be considered operational.

EFFECTS OF URBANIZATION ON SEDIMENTATION IN LAKE MATEOKA, WILLIAMSBURG AREA. M. G. Simpson*, J. A. Kohler*, and G. H. Johnson, Dept. of Geology, Col. of William and Mary, Williamsburg, Va., 23185

Lake Mateoka was impounded about 1700 and enlarged in the twentieth century. The lake basin is nearly one mile long, 400 feet wide at its maximum, and 17 feet deep near the dam. The basin is steep-walled except along the eastern and northern margins where deltas have modified the topography. A stream along the eastern bank of the lake, draining less than 5 acres, has built a 15,500 square foot delta containing more than 3000 tons of sediments during the last three years.

Bottom and suspended sediments were analyzed for organic matter, carbonate, and insoluble residue. The insoluble residue, composed principally of quartz and clay, was eroded from the uplands. In undeveloped branches of the lake the sediments contain more than 10% carbonate, 15% organic matter, and approximately 70% insoluble residue. Lake sediments adjacent to urbanized areas contain 10% carbonate, less than 5% organic matter, and more than 90% insoluble residue. Similarly, suspended sediment in the lake water was greater in the urbanized areas than in undeveloped areas. The influx of insoluble material has increased in the last 15 years due to the rapid but inadequately planned urban development in the northern and eastern drainage areas.

TOPOGRAPHIC MAPPING PROGRAM IN VIRGINIA

H. W. Webb; Va. Div. Mineral Resources, Ch'ville, 22903

A topographic map is a graphic representation in 2 dimensions of a part of the earth's surface, drawn to scale, with information depicted by standard colors and symbols. Over 850 different uses for maps have been developed. Of especial importance is their use in indicating potential industrial sites. Mapping began in Virginia in 1883. Since then with the need for more detailed and accurate information several map series have evolved; currently the State is being mapped by data from aerial photographs and ground studies at a scale of 1:24,000. In 1962 an accelerated mapping program with the U.S. Geological Survey began. By 1972, at a total cost of \$8,000,000, the State will be completely mapped. At present a map costs about \$18,000 and takes about 3 years to prepare. Two preliminary maps are available prior to the published map. To keep abreast of cultural development, maps are periodically being reviewed and recommended for revision updating. Revision data obtained from inspection of aerial photographs is being overprinted in magenta on existing map stock; areas of cultural growth are strikingly portrayed. Eleven cities currently have updated maps available. Information on the availability of different types of maps for Virginia can be obtained from the Va. Div. of Mineral Resources or the U.S. Geol. Survey.

EARTH SCIENCE EDUCATION IN VIRGINIA AND THE PROFESSIONAL GEOLOGIST. W. F. Young, Jr., State Department of Education Richmond, Virginia 23216

The adoption, for the first time by the State Board of Education, of textbooks for teaching a two semester course in earth science will result in an increase in the number of students taking earth science in Virginia public schools.

The opportunities for participation by professional geologists in this educational process will increase on a proportionate basis. These opportunities fall in three categories as follows: 1) furnishing field trip leadership for both students and teachers, 2) assist in the preparation of local field trip guides and road logs and 3) participation in the Virginia Academy of Science Visiting Scientist Program for Virginia High Schools.

With the exception of the third category, participation yields the greatest dividends when based on mutual respect between the individual teachers concerned and the participating professional geologist.

Professional geologists are urged to examine the adopted texts and curriculum guide. You are encouraged to determine your areas of interest and offer your services to a teacher or teachers of your choice.

Section of Materials Sciences

Forty-eighth Annual Meeting of The Virginia Academy of Science
May 6-8, 1970, Richmond, Virginia

GAMMA DOSIMETRY WITH ULTRAVIOLET TRANSMITTING PLEXIGLAS.
M. N. Bassim* (Now with the Materials Science Dept., Univ.
of Va.), J. L. Kelly* and K. R. Hall*. Dept. of Chemical
Engineering, Univ. of Va., Charlottesville, Va. 22903

The effect of gamma radiation from a manganese isotope activated in the University of Virginia Reactor core and allowed to decay, and from the University of Virginia Reactor core after shutdown, on the optical properties of ultraviolet transmitting (UVT) polymethyl methacrylate was investigated in order to determine the possibility of using this material for dosimetry. Plots were obtained that show the relation between the induced optical density and the total dose absorbed. This relation was found to be linear with the strength of the manganese source. With respect to direct radiation in the reactor, the relation is linear only when the plastic is irradiated at ice water temperature.

The effect of "bleaching", i.e. the recovery from irradiation was also investigated. It was found that lowering the temperature preserves the induced optical density for a long time. Storing in vacuum did not affect the rate of bleaching to a great extent.

DIFFRACTION OF HELIUM ATOMS IN SCATTERING FROM A CLEAVED LITHIUM-FLUORIDE SURFACE. J.R. Bledsoe* and S.S. Fisher. Dept. of Aerospace Engr. and Engr. Physics, Univ. of Va., Charlottesville, Va. 22901.

A thermal energy atomic beam of neutral helium atoms has been scattered from a cleaved lithium-fluoride surface under conditions where the deBroglie wavelengths of the atoms are comparable to the atomic spacing of the solid. The intensity and speed distributions of the scattered atoms were measured as a function of the reflected angle for fixed incident-beam conditions. After first heating the crystal in order to remove major surface contaminants, He scattered from the room temperature target exhibited sharp intensity maxima at the predicted diffraction-peak locations in accordance with simple theory. Speed distribution measurements confirm that elastic scattering predominates in the immediate vicinity of the diffraction peaks and that inelastic processes predominate between the peaks. The average speed of the scattered atoms as a function of reflected angle indicates that one-phonon energy exchange dominates the inelastic scattering. Therefore, the inelastic scattering yields information on the surface phonon spectrum of the target. (Research under NASA Grant NGR 47-005-046.)

INFLUENCE OF DISLOCATION SUBSTRUCTURE ON THE PRIMARY CREEP BEHAVIOR OF ALUMINUM. P. W. Chen*, and J. L. Lytton. Dept. of Metals and Ceramic Engineering, Va. Polytechnic Inst. Blacksburg, Va. 24061

Constant tensile stress creep tests were carried out at elevated temperatures on randomly oriented, high purity, polycrystalline aluminum in the as-recrystallized condition and after 5 and 10 pct prestrain and 300 hours recovery at 200°C. The apparent activation energy for creep of as-recrystallized aluminum at 1500 and 2000 psi between 160° and 200°C was 35,100 cal per mole. The shape of the primary creep curve varied drastically with differences in prior substructure. In aluminum given the 5 pct prestrain and 300 hours recovery at 200°C, the average subgrain intercept increased from 2.51 μ to 3.87 μ during creep while the creep rate decreased by a factor of ten. The creep rate extrapolated to zero strain for aluminum pretrained 10 pct and recovered 300 hours at 200°C was more than 10,000 times slower than that of as-recrystallized aluminum. The dislocation substructure generated during creep of aluminum was studied using both polarized light and transmission electron microscopy. The subgrain size observed was inversely proportional to the creep stress, the values using polarized light being about twice those from transmission electron microscopy. (Aided by NSF grant GK-1090)

EFFECT OF PRESSURE ON THE THERMAL CONDUCTIVITY OF POLYMERS. R. Y. S. Chen and R. E. Barker, Jr. Dept. of Materials Science, Univ. of Virginia, Charlottesville, Virginia 22901

Systematic measurement of the thermal conductivity of amorphous and partially crystalline polymers under pressure up to 2 kbar have been made. Experimental cells in the form of coaxial cylinders and symmetrical sandwiches were used and the thermal conductivities obtained were checked against each other.

Upon increasing the pressure, the thermal conductivities of polymethyl-methacrylate and polycarbonate (Lexan) increase at low pressure but are almost independent of pressure in the region from about 0.5 to 1 kbar. At the lower pressures, the relatively soft interchain (van der Waals) interactions determine the behavior but at higher pressures the distortion of bond angles has an increasing influence.

The effects of crystallinity on the thermal conductivity under high pressure and the change of the thermal conductivity at (or near) the glass transition under pressure are under investigation. The results will be compared with calculations based on Ehrenfest equations for second order transitions.

A THERMODYNAMIC INTERPRETATION OF SURFACE INDUCED MELTING OF SMALL PARTICLES. P. R. Couchman. Department of Materials Science, University of Virginia, Charlottesville, Virginia 22901

The high surface curvature of small particles produces large pressures on a solid-liquid system, thereby altering its melting temperature. A thermodynamic investigation of the conditions under which the melting temperature is raised or lowered is presented. For the models considered it is found that melting points of typical metals may be lowered by as much as 100°K from the bulk melting temperature at atmospheric pressure.

EFFECT OF LIQUID IMMISCIBILITY ON STRENGTH OF GLASSES IN THE $\text{Li}_2\text{O}-\text{TiO}_2-\text{SiO}_2$ SYSTEM. J. M. Fields, Jr.,* W. D. Leahy, Jr.* and J. J. Brown, Jr. Dept. of Met. & Cer. Eng., Va. Polytechnic Institute, Blacksburg, Va. 24061.

Preparation of bulk glasses from melts containing microscopic and sub-microscopic phase separation in the $\text{Li}_2\text{O}-\text{TiO}_2-\text{SiO}_2$ system increases the transverse bending strengths approximately three-fold over glasses prepared from single phase melts. Single phase annealed glasses were found to have typical bending strengths of 12,000 psi.; small amounts of phase separation increase these values in some cases to over 40,000 psi.; and further increases in the degree of phase separation eventually decreases the strength level rapidly. Significant strengthening was found to occur prior to loss of visible transparency. Glasses once strengthened by liquid immiscibility formation were successfully strengthened further by chill tempering to 80,000 psi. levels. These data are discussed in view of thermal expansion characteristics of the matrix and disperse glass phases, relationships between bulk composition and critical curve of the immiscibility dome, and microstructure of the immiscible glasses.

EFFECT OF SOME ORGANIC COMPOUNDS ON THE RATE OF CEMENTATION OF COPPER ON IRON. T. P. Floridis, Dept. of Metals and Ceramic Eng., Va. Polytechnic Inst., Blacksburg, Va. 24061

The principal reaction of the cementation of copper on iron is:



Two experimental procedures were followed for the study of the rate of cementation. In the first, an aqueous solution of copper sulfate was stirred by a rotating iron cylinder. In the second, sponge iron was agitated in an aqueous solution of copper sulfate. Aliquots were removed at successive time intervals and were analyzed for copper and iron. It was observed that small additions of some organic compounds were causing an increase of the rate of cementation. These compounds are: hexadecyltrimethylammonium bromide, propanol, ethanol, and methyl alcohol. All these compounds lower the surface tension of the solutions. Methyl isobutyl ketone substantially lowers the surface tension of the solution of copper sulfate, but it causes a decrease of the rate of cementation; this is tentatively attributed to the increased viscosity of the solution.

The author expresses his thanks to Mr. William M. Ervine for his technical assistance.

TRANSMISSION ELECTRON CHANNELLING PATTERNS IN SILICON. R. H. Geiss. Department of Materials Science, University of Virginia, Charlottesville, Virginia 22901

Transmission electron channelling patterns have been observed in nearly perfect silicon single crystals in an electron microscope having a single field condenser objective lens. Such patterns, which are complementary to the backscattered electron blocking patterns seen by Coates in the scanning electron microscope, are the same as convergent beam Kossel-Möllenstedt patterns. The unique feature of the patterns reported in this note is that because of the imaging properties of the single field condenser objective lens defects in the structure are seen in focus simultaneously with the channelling pattern. The potential advantages of this are obvious, e.g., the study of local lattice deformation at defects, orientation changes across boundaries, lattice potential studies and changes, if any, near defects, etc. (Supported by National Science Foundation Grant).

A THEORY OF PSEUDOMORPHISM. W. A. Jesser. Dept. of Materials Science, University of Virginia, Charlottesville, Virginia 22901

It is shown that the large interface to volume ratio found in thin bicrystal films can stabilize the overgrowth in the structure of the substrate rather than its normal bulk structure. Van der Merwe's expression for the misfit energy of an interface in conjunction with elastic strain energy calculations of Mott and Nabarro and Cabrera were employed to derive the critical deposit size beyond which a transformation from the pseudomorphic structure to the normal structure is favored. Two overgrowth forms are treated: i) continuous films of uniform thickness, and ii) hemispherical nuclei.

DENTAL AMALGAM AS AN ELECTRON COMPOUND. L. B. Johnson, Jr. Department of Materials Science, University of Virginia, Charlottesville, Virginia 22901

The extraordinary stability of the γ_1 phase of dental amalgam was believed to indicate that part of the Sn in dental amalgam was contained in this phase. By extending the Hume-Rothery "electron compound" ideas to the three component Ag-Sn-Hg system, an estimate was made of the amount of Sn which could be dissolved in $\text{Ag}-\text{Hg}$.

Spherical-particle Ag-Sn alloy powders ranging in composition from 4 to 24 atomic per cent Sn were amalgamated and the products examined by x-ray diffraction and metallography for the presence of the γ_1 phase and the $\gamma_1 \rightarrow \beta$ phase transformation. Further, a single amalgam of the approximate composition of dental amalgam was prepared from a melt and likewise examined.

Results showed that the solubility of Sn in $\text{Ag}-\text{Hg}$ is near 7 atoms of Sn per unit cell of the γ_1 phase. As clinically prepared, the γ_1 phase of dental amalgam contains, however, only about 5 atoms of Sn per unit cell. These 5 atoms, nevertheless, result in a very considerable stabilization of this phase due to the increase in its electron concentration.

WORKHARDENING IN DRAWN IRON WIRE. Doris Kuhlmann-Wilsdorf.
Dept. of Materials Science, Univ. of Va., Charlottesville,
Va. 22903

The unified theory of workhardening¹ that had earlier been derived with particular reference to face-centered cubic metals (e.g., copper, silver, gold, aluminum and others) has been rewritten in terms of the specific measurements made on drawn iron wire by G. Langford and M. Cohen. Numerical values for the full set of the various parameters appearing in the theory could be extracted from the micrographs published by these authors. The numerical values of the two parameters for which a theoretical estimate had been available were found very close to these estimates. Using the values of all parameters, the theory was then compared with the experimental results obtained by Cohen and Langford. All of the results were found to be in satisfactory agreement with the theory. In particular, the theoretically determined workhardening curve, beginning with 20% strain up to an elongation of the wire to 1500 times its original length, could be closely fitted to the corresponding measured curve. It is therefore concluded that the theory is applicable to drawn iron wire over a very wide range of deformations. By inference it is further concluded that the theory is applicable to a great variety of materials and modes of deformation. (Supported by AEC Contract No. AT-(40-1)-3108)

1) D. Kuhlmann-Wilsdorf - "Workhardening", (ed. J. P. Hirth and J. Weertman, Gordon and Breach, N.Y., 1968) pp 97-132.

THE CRYSTAL AND MOLECULAR STRUCTURE OF RUBIDIUM ADENOSINE DIPHOSPHATE. F. A. Muller and A. B. DeLuca, Dept. of Materials Science, School of Engineering and Applied Science, University of Virginia, Charlottesville, Va. 22901

The gross crystallographic data on rubidium-5'-diphosphate are as follows: $a = 28.46 \text{ \AA}$, $b = 10.60 \text{ \AA}$, $c = 6.32 \text{ \AA}$, $Z = 4$ molecules/cell, Space group = $P\bar{2}_12_12$. The structure was determined from three dimensional x-ray data and refined anisotropically by least squares methods to an agreement of better than 0.10. The details of the molecular arrangement show the adenosine unit to be similar to those found for the structure of adenosine monophosphate. The dihedral angle between the mean planes of the purine and ribose groups is about 66° and the glycosidic angle is about 38° (anti). The phosphate bond distances and angles are normal with staggered oxygen atoms. Ionic units are arranged on sheets of water molecules to which four oxygen atoms of the phosphate and ribose groups are hydrogen bonded. These oxygen atoms define a planar side to the ion which results from the particular relationship between the diphosphate and ribose groupings.

THE FCC-BCC TRANSFORMATION IN THIN PSEUDOMORPHIC IRON FILMS ON A COPPER SUBSTRATE. G. H. Olsen.
Department of Materials, University of Virginia,
Charlottesville, Virginia 22901

The influence of applied stress on the fcc-bcc transformation in thin iron films will be discussed. Various shear mechanisms by which this transformation may occur will be described. The effect of an applied stress on these shear mechanisms is to limit the number of possible orientation relationships between the fcc and bcc iron. Thin fcc iron on a copper substrate will be considered as a specific system in which the iron is put in tension by the copper. The results of Jesser and Matthews who studied the iron-nickel system will also be mentioned in this connection.

STRESSES OF DISLOCATION CELLS. Jon T. Moore*, and D. Kuhlmann-Wilsdorf. Dept. of Physics and Dept. of Materials Science, Univ. of Va., Charlottesville, Va. 22903

Dislocation cells are often seen in work-hardened and fatigued metals, being characterized by walls of high dislocation density enclosing an interior nearly free of dislocations. The simplest cell involving two perpendicular Burgers vectors is the terminating quadrupole, which consists of two mutually perpendicular, interpenetrating glide dislocation loops, the screw segments forming a simple twist boundary and the edge segments forming four simple tilt walls.

Any cell involving two perpendicular Burgers vectors can be thought of as being made up of a collection of quadrupoles, and in addition, the stress field of the quadrupole demonstrates most of the important features of that of the more complicated cell. In order to understand the interactions of cells with other cells and with individual dislocations, the electronic computer has been used to draw shaded contour maps of the stresses of the terminated quadrupole. (Supported by AEC Contract No. AT-(40-1)-3108)

AN ELECTROCHEMICAL METHOD TO PREDICT THE CORROSION RESISTANCE OF ALUMINUM CLADDING ALLOYS. H. E. Oliver* and H. Lee Craig, Jr. Metallurgical Res. Div., Reynolds Metals Company, Richmond, Va. 23218

Pure aluminum has a very high resistance to corrosion. As alloying elements are added in order to strengthen the metal by a subsequent combination of solution heat treatment and precipitation hardening, its resistance to corrosion generally decreases.

In the development of new alloys, there are at least two ways to predict their corrosion resistance:

- 1) Accelerated corrosion testing
- 2) Electrochemical measurements

With the first method a value of the corrosion current, a parameter related to the rate of corrosion, is calculated from weight loss data by the use of Faraday's law. With the second method corrosion current is determined directly from electrochemical measurements.

These two methods were used to determine values of corrosion current for alloys representing 7011 and 7072 with several different copper contents. A surprisingly close agreement of corrosion current values was found for each of the two alloy groups.

TEMPERATURE INDEPENDENT CONDUCTION IN SOME OXIDE THIN FILMS. L. H. Slack and R. W. Frankson*. Dept. of Met. & Cer. Engr. Va. Polytechnic Inst., Blacksburg, Va. 24061

Several oxide thin films have been discovered which have very low temperature coefficients of resistance. Films of manganese oxide and iron oxide were studied to determine the effects of heat treatment and thickness on the temperature coefficients of resistance and sheet resistances. Heating manganese oxide films to 250°C in air caused the temperature coefficient of resistance to drop to 16 ppm/°C. Electron diffraction revealed that this film consisted of FCC MnO and the crystallite size was so small that the film structure was approaching noncrystallinity. Electron micrographs of MnO and films formed by evaporating Fe₂O₃ are presented.

A NETWORK REPRESENTATION OF THE TOPOLOGICAL CHANGES DURING SINTERING. James H. Steele, Jr. Dept. of Met. & Cer. Engr. Va. Polytechnic Inst., Blacksburg, Va. 24061

Two of the important structural changes which occur during the sintering process are a decrease in connectivity and a separation of the initially continuous pore structure. These changes, which represent the topological evolution of the structure, occur over two-thirds of the range of densification.

A Monte Carlo type computer simulation has been developed to study this topological evolution for loose packed sinter bodies. The simulation is based upon the pinching-off (closure) of pore connections (channels) as the solid aggregate densifies. The channel closure event is applied randomly to a network representation of the interstitial-like pore space, and the changes in connectivity and number of separate parts for various network representations are obtained. The topological evolution generated by this model shows excellent agreement with available experimental measurements. The theoretical data yield estimates for the fraction of channels which must be closed, to begin separation of pore space, and to reduce the connectivity to zero.

Correlation of the computer data with available experimental results indicates that a random channel closure model can explain the topological changes which occur during sintering.

DESIGN OF AN APPARATUS FOR THE PURIFICATION OF MATERIALS BY CHLORINATION AT HIGH TEMPERATURES. W. Tropf*, Dept. of Physics, Univ. of Va., Charlottesville, Va. 22903

An apparatus is described which removes contaminants from graphite crucibles, as first suggested by Z. S. Basinski. The design and construction of a system to remove contaminants from crucibles by immersion in chlorine at white heat, and subsequent deposition of impurities in a cold trap, is discussed in detail. Highly pure crucibles thus treated are required for the growth of single crystals of the highest quality. (Supported by AEC Contract No. AT-(40-1)-3108)

MEASUREMENT OF THE DIFFUSION COEFFICIENT OF GASES IN ACRYLIC FILMS. R. A. Willency^{*} and R. E. Barker, Jr. Department of Materials Science, University of Virginia, Charlottesville, Virginia 22901

A mass spectrometric technique for the measurement of diffusivity of gases in polymer films has been developed. The method employs boundary conditions suitable for the application of Daynes time-lag solution to Fick's second law. The use of the mass spectrometer for the measurement of gas transport has the advantages of sensitivity and selectivity as well as the capability for observation of transport of several gases simultaneously. The diffusivity of Argon in an amorphous acrylic film has been determined by this method to be $2.1 \times 10^{-10} \text{ cm}^2/\text{sec}$ at 27°C. Work is continuing with this material to clarify the effect of controlled changes in morphology, in particular uniaxial orientation, on the diffusivity.

CHARACTERIZATION AND DETERMINATION OF CRYSTAL MISORIENTATION AND ASSOCIATED BOUNDARIES BY MEANS OF ELECTRON DIFFRACTION PATTERNS. C. T. Young*, J. H. Steele, Jr., and J. L. Lytton. Dept. of Metals and Ceramic Engineering, Va. Polytechnic Inst., Blacksburg, Va. 24061

Angle of misorientation, axis of rotation, and boundary normal are the three general parameters used to characterize the orientational relationship of two adjacent crystals and the associated boundary. The first two parameters can be determined accurately using Kikuchi patterns taken from each of the two crystals. A mathematical analysis using matrix algebra is being developed for computer calculations. The third parameter can be obtained if foil thickness can be determined. A second analysis is being developed to determine the boundary normal without knowing the foil thickness. This is done by taking micrographs and Kikuchi patterns from the same area before and after performing a given specimen tilt. The rotational matrix can be obtained from these two Kikuchi patterns. Using this matrix and the change of the projected images as a result of tilting, the boundary normal, foil normal, and foil thickness can be calculated. (Aided by NSF grant GK-10972)

Section of Medical Sciences

Forty-eighth Annual Meeting of The Virginia Academy of Science
May 6-8, 1970, Richmond, Virginia

ALTERATIONS IN RAT LIVER AMINO ACID POOLS BY HYDRAZINE.
W. L. Banks, Jr. and O. M. Peterson. Dept. of Biochem.,
Med. Col. of Va., HSD, Va. Commonwealth Univ., Richmond, Va.
23219

The nature of the amino acid pools was assessed in rat liver following treatment with neutralized hydrazine (40 mg/kg body weight). Groups of control and hydrazine-treated animals were sacrificed at 4, 12, 24, 36 and 48 hrs. The rats were fasted during the experimental periods and compared to a fed control group. Protein free filtrates were prepared from pooled liver homogenates and free amino acid profiles estimated by elution chromatography. Many of the free amino acids exhibit essentially the same time course behavior in the hydrazine and control livers. A rhythmic pattern of decreases followed by increases at 12 hr. intervals was established at 12 hrs. for most of the protein amino acids. Hydrazine treatment produced increased levels of ornithine, citrulline, alanine, α -methyl- β -hydroxy acid and lowered tyrosine levels. In comparison to their fasted controls, the hydrazine-treated animals showed little difference in the behavior of their free essential amino acids as a group, whereas the nonessential amino acid levels were elevated between the 12 and 36 hr. intervals. These results cannot be explained solely on the basis of inhibition of transamination by hydrazine. The temporal sequence of increased amino acid levels in the liver corresponded with the hydrazine-induced stimulation of protein synthesis reported previously.

THE HUMAN "ALBUMINS": MICRO AND MACRO HETEROGENEITY. E. R. Berry. Dept. of Biophysics, Med. Col. of Va., Richmond, Va. 23219

The conventional conditions of agarose-gel electrophoresis may be given another dimension. After the usual electrophoresis, a 1 mm section is cut parallel to the direction of migration and this section is then re-run but at 90° to its original position. Fractionation produced by the first migration is preserved in the section and can now be observed by scanning the final pattern at intervals of 0.5 mm. A three-dimensional plot of the serial patterns, or two-dimensional, depicts the areas of multiple boundaries (macro-heterogeneity) among the albumins of slower mobility and a remarkable micro-heterogeneity in those of faster mobility. The inclusion of the pre-albumin and the alpha areas is necessitated by proximity and the same complexity is observed. An analysis of a plasma from a patient with nephrosis and one from a patient with hepatitis are discussed in regard to boundary shape, mobility, concentration and biochemical individuality.

Research support was by contracts with D.A.S.A. and N.A.S.A.

BILIARY LIPID METABOLISM IN MAN. C. Cooper Bell, Jr., Z. R. Vlahcevic, and Leon Senn. Dept. of Surgery, Medicine, and Biochemistry, McGuire V. A. Hosp. and Med. Col. of Va., Richmond, Va. 23219

Cholesterol is solubilized in bile with lecithin and bile salts as a mixed micelle. If the lecithin and bile salts to cholesterol ratio falls below a critical level, cholesterol will appear in bile in a crystalline form. We have shown, using isolated perfused dog and rat livers, that bile salts are necessary for the biliary excretion of sufficient amounts of bile salts and lecithin to keep cholesterol in solution (i. e., in the micellar zone). We have demonstrated that patients with cholesterol gallstones have cholesterol crystals in their bile. They also have a significantly reduced total bile acid pool and cholic acid synthetic rate. Further studies in man revealed that the liver, not the gallbladder, is the site for the production of abnormal bile found in patients with cholesterol gallstones. Patients with T-tube drainage of their common bile duct have conversion of their lithogenic bile to a normal bile by the oral administration of bile salts. These studies suggest that in man the level of bile salts in the enterohepatic circuit is a major factor controlling the biliary excretion of lecithin and to a lesser extent cholesterol.

THE INTRACELLULAR PROTEIN CHANGES IN TISSUE CULTURE OF LENS EPITHELIUM. E. R. Berry and W. J. Geeraerts. Depts. of Biophysics and Ophthalmology, Med. Col. of Va., Richmond, Va. 23219

Human lens epithelium was obtained from cataractous lenses and from clear dislocated lenses. The dissected capsule with adherent epithelium was divided into two parts and placed on cover slips within a petri dish. MEM was then added to cover the preparation. Medium was changed daily for three day, than twice a week until satisfactory growth resulted. After 2-3 weeks the original explants were removed and the growth allowed to cover the cover slip. Samples were removed at intervals for electrophoretic analysis. Microphotographs are presented with the patterns obtained at time intervals through the explant removal and past. The consistent loss of the albumin and gamma boundary and the gradual "smudging" of all areas into intermediate mobilities is presented. The possible effect of the capsule membrane on protein composition is discussed.

Research supported by NASA, 47-002-005 and NIH Training Grant, 5-T01-NB05176-10.

URINARY EXCRETION OF A CARBOXYLIC ACID FOLLOWING ADMINISTRATION OF TERRAZOLE, 3-TRICHLOROMETHYL-5-ETHOXY-1,2,4,6-TIADIAZOLE. Edward R. Bowman, M. S. Dar, and Herbert McKennis, Jr., Dept. of Pharmacology, Med. Col. of Va., Richmond, Va. 23219; and Edward J. Kuchar*, Olin Corporation, New Haven, Conn. 06504.

After administration of Terrazole, 3-trichloromethyl-5-ethoxy-1,2,4-thiadiazole to the rabbit and the rat, respective urines were acidified and exhaustively extracted with ether to obtain a crude acidic substance which was purified by processing on Dowex 21 KOH⁻ and subsequent conversion to a benzylammonium salt, m.p. 174-176°. Elementary analysis suggested an empirical formula C₁₂H₁₃N₃O₂S. A solution of the salt in aqueous HCl was extracted with ether to obtain the parent acid, m.p. 124-126°—with empirical formula C₈H₁₁N₃O₂, confirmed by mass spectrometry. Additional experiments with Terrazole-¹⁴C, and lettuce and potato homogenates provided evidence for an apparently similar degradative route in plant material. Studies on the stability of dilute aqueous solutions of Terrazole in the range of pH 2.7 to pH 7.3 serve to suggest that the formation of 3-carboxy-5-ethoxy-1,2,4-thiadiazole may proceed effectively even in the absence of enzymatic activity. Thus "spontaneous hydrolysis" with formation of a readily water-soluble product provides, as shown with Terrazole-¹⁴C, an effective route for elimination of the parent compound.

HYDROLYSIS AND EXCRETION OF ESTERS OF EDTA AND EGTA AFTER ORAL ADMINISTRATION TO RATS. J.F. Borzelleca and B. van't Riet. Depts. of Pharmacology and Chemistry and Pharmaceutical Chemistry, Med. Col. of Va., Richmond, Va. 23219

The disodium salts of EDTA and EGTA and their tetra esters, Me₄ EDTA, Et₄ EDTA, Et₄ EDTA, were administered in doses of 400 and 1000 mg/kg via stomach tube to fasted adult male Sprague-Dawley rats. Absorption of the disodium salts was apparently limited. Less than 10% of the administered doses was recovered in the 96 hour period following dosing. The major excretion occurred within the first 24 hours. The remainder (90 ± 7%) was recovered in the feces. The tetra-esters were apparently better absorbed. The partially and completely hydrolyzed forms were detectable in the urine within 3 hours after dosing. Within 96 hours, the following percentages of the total administered doses were recovered in the urine: Me₄ EDTA, 55%; Et₄ EGTA, 37%; Et₄ EDTA, 48%. The remainder was recovered in the feces. The urinary excretion of calcium was increased following the oral administration of the disodium salts and the tetra-esters. The greatest increase was seen following the administration of Me₄ EGTA, 1000 mg/kg. This was accompanied by a marked increase in urine volume. The tetra-esters were not detected unchanged in the urine or feces, but at least 70% of the high dose of Et₄ EDTA and 40% of Me₄ EGTA were recovered in only partially hydrolyzed forms in the urine. These forms appeared to complex with calcium to a lesser extent than the ions of the tetraacids.

(Supported by NIH grant AM 13, 816-01.)

PLASMA PROTEINS AND HOMOTRANSPLANTATION. Francis M. Bush, and J. Ives Townsend, Depts. of Anatomy and Genetics, Med. Col. of Va., Richmond, Va. 23219

Prognosis of several diseases is achieved by electrophoresis of plasma proteins. Study after transplantation reveals major changes in globulins. Levels of a γ-globulin increase after homotransplantation of mouse skin, dog liver, heart and human kidney. Inconsistencies occur in γ-globulin levels during rejection of human kidney and dog heart. Other changes after homotransplantation in man and dog are: a new β₁-globulin, abnormal γ-globulin, and an absent or a transient α₁-globulin.

Studies of plasma enzymes, lactate and malate dehydrogenases, alkaline phosphatase, aldolase, and amylase, after transplantation show changes either in levels of electrophoretic bands or of total activity. Increases in levels exist in dog and human renal recipients undergoing rejection.

Success of graft retention is related to the extent of similarity of plasma proteins in donor and recipient. Increased skin graft survival occurs in human recipients when their donors have similar β₁-lipoprotein types. Albumin-globulin ratios show successful parabiosis in rats, ratios are dissimilar if parabiosis is successful and similar if unsuccessful.

This report discusses the explanations of the effects on plasma proteins by transplantation and considers prospects for using plasma proteins to promote and to predict homograft success.

STUDIES ON THE OXIDATIVE DEGRADATION OF BETAHISTINE (SERC) IN THE RABBIT. Faye J. Bowman*, Edward R. Bowman, and Herbert McKennis, Jr., Dept. of Pharmacology, Med. Col. of Va., Richmond, Va. 23219.

Betahistine [2-(2-methylaminoethyl)pyridine] (100 mg/kg body wt) was administered via gavage to female Dutch rabbits. The animals, provided food and water ad libitum, were housed in metabolism cages and urine was collected for 48 hours. Pooled urine from six animals was treated with Dowex 50(H⁺), then eluted with 5 N ammonia hydroxide. Following processing of the ammonia eluate on Dowex 21 KOH⁻, a 2 N acetic acid eluate provided material which had ultraviolet absorption properties corresponding to 2-pyridylacetic acid. Thin layer chromatograms (alumina) of the acetic acid eluate and standard 2-pyridylacetic acid revealed one Koenig-positive zone (R_f 0.1) using 80% methanol solvent system. The crude acid was converted to methyl 2-pyridylacetate picrate which was identified by elemental analysis and by comparison with authentic methyl 2-pyridylacetate picrate. The data suggest, although precise methods are not yet available for determining small quantities of betahistine and its metabolites, that the urinary excretion of 2-pyridylacetic acid provides a major route for elimination of administered betahistine.

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HISTOLOGICAL AND ULTRASTRUCTURAL ASPECTS OF THE PRONEPHRIC PHASE OF RENAL DEVELOPMENT IN THE LARVAL STRIPED BASS, *ROCCUS SATILLIS* (WALBAUM). C.P. Bryant* and H.R. Seibel. Dept. of Anatomy, Med. Col. of Va., Richmond, Va. 23219

The pronephros of yolk-sac larvae and early stage juveniles of *Rooccus satillalis* were observed by light and electron microscopy. In early 1 day specimens paired pronephric ducts appear as far rostrally as the heart along the ventral aspect of the differentiating lateral plate mesoderm. Two to three pairs of uriniferous (pronephric) tubules are present and communicate with the coelomic cavity via nephrocoels. By day 4 the rostral portion of the pronephric duct has disappeared caudally to the level of the developing pectoral fins. Only one pair of pronephric tubules is still apparent. A single pair of glomeruli have formed as ventrolateral buds from the dorsal aorta. Cells lining the persisting nephrocoel proliferate to form an epithelial capsule which encloses the glomerulus and becomes continuous with the cells lining the pronephric tubule. A communication between this nephrocoel capsule and the coelomic cavity persists but by 1 week, proliferation of capsule cells closes the channel. The pronephric ducts extend caudally to the region of the hind-gut where they converge medially to join the cloaca.

Electron microscopy reveals extensive glycogen and smooth ER in duct cells and abundant rough ER in tubule cells. Mitochondria exhibiting tubular cristae appear more numerous in tubule cells but considerably larger in duct cells.

ANTAGONISTS OF CORTICAL HORMONES AND DISEASE ACQUISITION. G. Colmano and W.B. Gross, Dept. Vet. Sci., V.P.I., Blacksburg, Va. 24061.

We have shown a constant correlation between high level plasma corticosterone (fluorimetrically measurable), susceptibility to viral infections, and resistance to bacterial infections. Increasing stress increases the susceptibility of chickens to viral infections from Newcastle Disease and Hemorrhagic enteritis, and also increases mortality from Marek's disease, as opposed to increased resistance to bacterial infections from *Escherichia coli*, *Staphylococcus aureus* and *Streptococcus fecalis*. Through determination of blood plasma corticosterone levels and by mating of high and low corticosterone lines, we have produced a selection pressure toward high and low stress-corticosterone birds, which confirms the above relationship to disease acquisition, and may be simulated by ACTH and corticosterone injection. When a high level corticosterone bird is challenged with either a bacterial or viral agent, the corticosterone production is hyperstimulated and further reduces the resistance of the animal to a viral infection. We have sought corticosteroid blocking agents capable of minimizing this hyperstimulation. Two 11β-hydroxylation blocking agents, metyrapone and dichlorodiphenylchloroethane, have shown an effective lowering of blood plasma corticosterone and of viral infections, including the limphoneoplastic activity of Marek's disease.

INFLUENCE OF ADRENALECTOMY AND STEROID REPLACEMENT ON NORADRENALINE BIOSYNTHESIS. J. W. Dailey,* and T. C. Westfall. Dept. of Pharmacology, Univ. of Va. School of Medicine, Charlottesville, Va., 22903

It has recently been reported, from our laboratory, that the simultaneous daily administration of desoxycorticosterone acetate (DOCA) and hydrocortisone (HC) prevented the increase in heart H³-noradrenalin (NE) turnover observed after adrenalectomy (ADX) (J.P.E.T. 169: 300, 1969). In the present experiments, the effects of DOCA, HC or corticosterone (C) on NE turnover were studied individually 6-9 days after ADX. The turnover of H³-NE was compared in normal, ADX and ADX animals receiving daily injections of either HC, C or DOCA. NE was measured fluorimetrically and by scintillation spectrometry and turnover calculated by the method of least squares. The turnover increased following ADX and this increase was prevented by the daily administration of DOCA (2 mg/kg, or 0.5 mg/kg), but not by 2 mg/kg of either HC or C. The increase in NE turnover, resulting from ADX, does not appear to be due entirely to the decrease in blood pressure that is also associated with ADX since the decrease in blood pressure can be prevented by either HC, C or DOCA. (Supported, in part, by USPHS Grant GM-40657-02 and Council for Tobacco Research, USA, 467A-R1.)

THE MEASUREMENT OF TESTOSTERONE IN MALE PLASMA BY COMPETITIVE PROTEIN BINDING. C. H. Duval!*[†], M. A. Mackler*, G. R. Prout, Jr.*[‡], and J. P. Liberti. Dept. of Biochemistry, Med. Col. of Va., Richmond, Va., 23219

An accurate and reproducible procedure is described for the determination of testosterone from male plasma using competitive protein binding. A single TLC using alumina adsorbent is sufficient to effect separation of testosterone from C₁₉ steroids which could interfere with the protein binding reaction. One ml of plasma is required to satisfactorily measure testosterone in plasma from normal or orchiectomized males. The mean recovery of testosterone in approximately 300 samples was 60 ± 10% (S. D.). The mean plasma testosterone level in 50 normal men was 5.6 ± 2.3 µg/ml, which agrees well with literature values. In 30 patients with carcinoma of the prostate, the mean was 7.9 ± 2.2 µg/ml (S. D.) which decreased to 0.6 µg/ml after orchiectomy.

MECHANISM OF ACTION OF METHYLREDNISOLONE IN THE TREATMENT OF HEMORRHAGIC SHOCK. Thomas M. Glenn and Allan M. Lefer. Dept. of Physiology, Univ. of Virginia Sch. of Med., Charlottesville, Va., 22901

Gluocorticoids are known to be of value in the treatment of various forms of shock, particularly when given prior to or early after the induction of the shock state. However, the mechanism of the protective effect is not known. We studied the effects of methylprednisolone on hemorrhagic shock in the cat, measuring hemodynamic data, survival time, plasma activity of two lysosomal enzymes, β-glucuronidase (BG) and plasma carboxypeptidase-like activity (PCLA) and a myocardial depressant factor (MDF), a toxic factor produced in hemorrhagic shock as a result of splanchnic ischemia. Methylprednisolone (20 mg/kg) given intravenously 1 hour prior to hemorrhage resulted in a threefold increase in postreinfusion survival time compared with the diluent treated cats without any significant alterations in mean arterial blood pressure, central venous pressure and heart rate. Plasma MDF activity of the steroid treated cats was 19 ± 3 units compared with 51 ± 2 units for the diluent treated cats. Furthermore, methylprednisolone prevented the rise in plasma BG and PCLA which increased 3 to 4 fold in the unprotected cats. Methylprednisolone (20 mg/kg) given to non-shocked cats exerted no hemodynamic effect over a 3 hour period. These data are consistent with the hypothesis that glucocorticoids protect in shock by preventing lysosomal disruption, which would lead to protease release and the subsequent production of toxic factors such as MDF.

METHYLAMINE AND METHYLUREA--THEIR METABOLIC INTERRELATIONSHIPS. M. S. Dar, Dept. of Pharmacology, Med. Col. of Va., Richmond, Va., 23219.

The metabolism of methylamine has been investigated in the rabbit and the rat, and evidence has been presented to show that the metabolism of the compound leads to the formation and excretion of methylurea, a metabolite suspected but never conclusively shown to exist by previous investigators. Urinary methylurea, after the administration of methyl-¹⁴C-amine was shown to have ¹⁴C-activity at both the carbonyl and methyl groups of the molecule. The presence of ¹⁴C-activity in the carbonyl group served to suggest that the carbonyl group of methylurea was derived from the same metabolic pool of CO₂ that is used in the formation of urinary urea and respiratory CO₂. In a series of experiments in rabbits using N-methyl-¹⁴C-urea, radioactivity was found in the carbonyl group of urea and urinary methylamine. In comparable experiments with N-methylurea-¹⁴C-carbonyl, urinary urea contained a 200-fold excess of ¹⁴C-activity and urinary methylamine was virtually devoid of radioactivity. These data indicate metabolism of methylurea to urea with maintenance of the integrity of one or more of the nitrogen-carbon bonds of methylurea. The present data do not permit exclusion of either route (ammonolysis or direct demethylation) as a participating factor in the demethylation of methylurea, and point to desirability for additional studies for complete elucidation of the mechanisms involved.

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STUDIES OF SERUM LIPIDS IN CARDIOVASCULAR DISEASE. J. C. Forbes and O. M. Petterson, Dept. of Biochemistry, Med. Col. of Va., Richmond, Va., 23219

Sera from normals and subjects with cardiovascular disease were analyzed for serum cholesterol and triglycerides. Low-density lipoproteins were precipitated with dextran sulfate plus calcium chloride and analyzed for cholesterol, triglycerides and protein. The results showed that the ratio of cholesterol to protein in the dextran sulfate precipitable material remained relatively constant. It would appear that a slow increase in the low-density lipoprotein cholesterol concentration tends to be associated with a corresponding increase in the protein moiety. This is in agreement with previous studies on experimental animals (1). No definite difference in the ratio of cholesterol to protein could be demonstrated between normal subjects and those with cardiovascular disease. The results showed no apparent correlation between triglycerides and protein concentrations.

(1) Forbes, J. C., Rudolph, R. A., Jr., and Petterson, O. M., Va. J. Sci. 20, 47 (1969).

THE COMPARATIVE ANATOMY OF THE EPITHALAMUS IN SOME COMMON LABORATORY RODENTS. Joseph C. Gregorek* and Hugo R. Seibel. Dept. of Anatomy, Med. Col. of Va., Richmond, Va., 23219

The pineal body originates from the area between the habenular commissure and the posterior commissure of the epithalamus. It varies in structural organization in the different rodents but is primarily composed of masses of pinealocytes. A pineal sac of eosinophilic staining cuboidal epithelial cells extends anteriorly to the pineal organ. It is continuous and histologically identical to the choroid plexus of the third ventricle.

The pineal complex of the golden and Chinese hamster is divided into a deep pineal and superficial pineal body; the deep pineal body is part of the diencephalic roof while the superficial is connected to it via a pinealocyte stalk. The pineal sac adheres to the deep pineal, the stalk, and the superficial pineal in the golden hamster but only to the deep pineal and stalk in the Chinese hamster.

The albino rat and kangaroo rat have only a superficial pineal body; it is connected to the brain via a connective tissue stalk and pinealocyte stalk in the albino rat and kangaroo rat respectively. The pineal sac never abuts true pineal parenchyma in the albino rat and most kangaroo rats.

The pineal in the immature cotton-tailed rabbit is an elongated solid parenchymous mass of cells extending from the diencephalon and its pineal sac extends along its anterior surface. (Supported in part by A. D. Williams Grant 3558 (585).)

THE PROSIMIAN PRIMATE *GALAGO SENEGALENSIS* AS A RESEARCH ANIMAL. D. E. Halnes*, J. E. Norwell and K. R. Holmes*. Dept. of Anatomy, Med. Col. of Va., Dept. of Physiology, Mich. St. Univ.

The lesser bushbaby *Galago senegalensis* is a member of the infraorder Lorisiforms and the family Lorisidae. *Galago senegalensis* is native to most of Africa south of the Sahara desert.

In the laboratory the *Galago* is maintained in stainless steel cages measuring about 71.0 x 42.5 x 62.5 cm. A wooden or stainless steel nesting box is provided in each cage. Specially made invertable water bottles of about 125 ml capacity with a screw-on plastic top are used. The daily dietary intake consist of pulverized monkey chow (15-25% protein) mixed with bananas to form a moist palatable mixture. Every other day a vitamin supplement is added to this mixture.

The *Galago* has a hemogram similar to that of higher primates and man. The gestation period is about 120-146 days, considerably longer than other small non-primate mammals. The female *Galago* may have as many as two sets of young per year. The unique anatomy of the higher primates and man is reflected in modified form in the *Galago*. Adult females range from 200-315 gms and adult males from 275 gm up.

The animal size, ease of handling and low cost of maintenance required in the *Galago* colony make this an attractive animal for the research laboratory. (Aided by A. D. Williams Grant 3558-510).

CELLULAR AND HUMORAL ASPECTS OF HOST RESISTANCE IN TUBERCULOSIS. H. S. Hsu, Dept. of Microbiology, Med. Col. of Va., Richmond, Va. 23219

A tissue culture procedure was designed to study the fate of tubercle bacilli within macrophages and the cellular response to infection. No difference was seen in the growth rate of tubercle bacilli within macrophages of natively resistant or natively susceptible rabbits. The bacilli could accumulate within host cells of natively resistant rabbits, while the cellular morphology remained intact. By contrast, the infected cells from natively susceptible rabbits were damaged, with few intracellular bacilli. Macrophages of cortisone-treated guinea pigs behaved in the same manner to intracellular infection as cells of natively susceptible rabbits. BCG-vaccination of rabbits or triiodothyronine-treatment of guinea pigs conferred on host macrophages an enhanced capacity to suppress the rate of intracellular bacterial multiplication, independent of humoral antibodies. On the other hand, the presence of immune serum in the culture medium did not alter the fate of intracellular bacilli, but it protected the host cells of natively susceptible rabbits or cortisone-treated guinea pigs from cytotoxic injury.

A HISTOLOGICAL COMPARISON OF THE NORMAL AND RESERPINATE-TREATED RABBIT AORTA. T. M. Harris* and P. M. Hudgins*, Dept. of Anatomy and Pharmacology, Med. Col. of Va., Richmond, Va. 23219

Sections of thoracic aorta were taken from 5 control and 7 reserpine treated New Zealand White rabbits that weighed 2-3 kg. Tissue sections were stained with hematoxylin and eosin, a modified Masson's trichrome, or Weigert's resorcin-fuchsin stain for elastic tissue. The treated animal received 0.3 mg/kg reserpine each day for three days and were killed on the fourth day by air embolism.

The rabbit aorta was found to exhibit several features that have not been previously reported for mammalian elastic arteries. The tunica media is organized into three zones of approximately equal width; they are: (1) an inner circular zone of thin layers of smooth muscle and elastic lamellae, (2) a middle circular zone of thick layers of smooth muscles and elastic lamellae, and (3) an outer longitudinal zone of thick layers of smooth muscle and elastic lamellae. The oval nuclei of the endothelial cells are oriented parallel to the long axis of the vessel.

Aortae from treated animals differed markedly from the controls. The extent of the variation differed among the three zones of media. The variations were all indicative of an atonic condition in the vessels which is compatible with the role of reserpine as an adrenergic blocking agent. (Supported by PHS grant NS 07752).

LIVER ORNITHINE DECARBOXYLASE IN HYDRAZINE TREATED RATS.

V. S. Hubbard* and W. L. Banks, Jr. Dept. of Biochemistry, Med. Col. of Va., HSD, Va. Commonwealth Univ., Richmond, Va. 23219

Ornithine decarboxylase (ODC) catalyses the conversion of ornithine to putrescine which is an immediate precursor for the biosynthesis of the polyamines, spermidine and spermine. Polyamine levels, especially spermidine, have been correlated with RNA synthesis. Since rats treated with hydrazine show increased liver protein and RNA levels, the effect of hydrazine on ODC activity was studied. Enzyme activity was assayed in a 20,000 x g supernatant from rat liver. The reaction was followed by trapping and counting released $^{14}\text{CO}_2$ from ornithine-1- ^{14}C . Growing (110 g) and adult (400 g) rats were injected with neutralized hydrazine (40 mg/kg, i.p.) and fasted for various times. In animals sacrificed four hours after administration of the compound, enzyme activity was approximately 20-fold higher than in fasted, untreated rats. A similar (20-fold) increase in ODC activity due to liver regeneration was noted at sixteen hours following partial hepatectomy (67%) in comparison to fed, fasted, or sham-operated controls. The stimulation of ODC activity following either hydrazine treatment or partial hepatectomy appears to precede the time at which increased RNA levels have been reported by others. Thus, ODC activity may act as a regulator of RNA synthesis.

STUDIES ON MICROSOMAL ACYLATION REACTIONS INVOLVED IN GLYCEROLIPID METABOLISM. H. N. Hughes* and P. F. Jezeky, Dept. of Biochemistry, Med. Col. of Va., Richmond, Va. 23219

The properties of cellular membranes are strongly influenced by the acyl group composition of their glycerolipid components. Acyl CoA: lysophospholipid acyl transferases may play an important role in determining the acyl group composition of ethanolamine and choline phosphoglycerides. However, these enzymes are membrane-bound and have been refractory to purification. Little, therefore, has been learned about the number or absolute specificities of these enzymes. Utilizing techniques similar to those described previously (Jezeky, Va. J. Sci., 1968), we have prepared a series of analogs of the natural 1-acylphosphoglycerides differing only in the phosphate ester constituent. With pig liver microsomes as the enzyme source, the relative affinities of the acyltransferase for 18:2 CoA are choline > dimethyllethanolamine > monomethyllethanolamine > ethanolamine > ethanol. Affinity values for this series correlate quite well with the π -electron charge on the nitrogen, which is necessary to obtain significant rates of acylation. Results with other substituents differing in alkyl chain length, branching or position of amino group indicate that spatial relationships also play an important role in the specificity. Further studies are now under way to determine whether or not the same affinities will hold for other acyl CoA substrates or with enzymes from other tissues.

X-IRRADIATION EFFECTS ON THE BEHAVIOR OF THE ADULT MALE RAT. J. B. Kirkland, Jr.* E. H. Ingersoll and A. L. Carsten*. Dept. of Anatomy, Med. Col. of Va., Richmond, Va. 23219 and Medical Dept., Brookhaven National Laboratory, Upton, N. Y. 11973

Adult Sprague-Dawley male rats were administered either 2,500 or 5,000 rads x-irradiation to the forebrain and then tested for deficits in learning in an alley runway at 8, 12, 18 or 32 weeks post-irradiation.

Significant learning deficits were not found for the rats irradiated at 2,500 rads. Neither did learning appear to be enhanced by the radiation; rather there appeared to be no difference in the ability of the controls and the experimental animals to learn patterned running in the alley runway (for methods see Proc. Soc. Exp. Biol. and Med., vol. 125, p. 382, 1967).

In the animals irradiated with 5,000 rads learning deficits were demonstrated only at 8 weeks post-irradiation. In the other three groups the irradiated rats performed equally as well or better than their controls. (Aided by funds from the School of Dentistry, M.C.V. and the Medical Department, Brookhaven National Laboratory).

ON THE VASODILATOR EFFECT OF BETAHISTINE (SERG) AND RELATED SUBSTANCES IN THE PERFUSED FORELEG OF THE DOG. H. Konzett and R. Bost, Dept. of Pharmacology, Med. Col. of Va., Richmond, Va., 23219.

The right forelimb of each of 26 dogs, under sodium pentobarbital anesthesia (30 mg/kg) and artificial respiration, was perfused at constant flow with heparinized blood from the ipsilateral femoral artery into the cannulated brachial artery. Pressures in the ulnar artery near the carpus, in a superficial vein of the forepaw, and in the left carotid artery were continuously measured and recorded. Infusion into the brachial artery with betahistine [2-(β -methylaminoethyl)pyridine] or 2-(β -aminoethyl)pyridine at dosages of 0.22, 0.67, and 2.2 μ moles/min. produced a fall in the perfusion pressure of the ulnar artery without changing either the venous pressure or the carotid artery pressure. The compounds showed similar qualitative and quantitative effects. Histamine, in molar concentrations one twentieth that of betahistine and 2-(β -aminoethyl)pyridine, produced a decrease in the perfusion pressure which was similar to the decrease produced by the two compounds. By pretreatment with an antihistamine, chlorpheniramine maleate (20 mg for 2-4 min.), the effects of histamine as well as betahistine on the perfusion pressure were diminished. Neither atropine nor the monoamine oxidase inhibitor, tranylcypromine, altered the response to betahistine or 2-(β -aminoethyl)pyridine.

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MEASUREMENTS OF THE ELECTRICAL ACTIVITY OF THE FROG SCIATIC NERVE AS AFFECTED BY Na^+ , K^+ , AND Li^+ . Joseph R. Loche, 5318 Pillow Lane, Springfield, Va., 22151 (Springfield High School).

This experiment was undertaken to determine the effects of Na^+ , Li^+ , and K^+ on the electrical activity of the sciatic nerve trunk of the frog. These measurements, made using stainless steel external electrodes, were of three types: 1) measurements of the action potential, 2) measurements of the resistance and potential exhibited across the epineurial membrane when various solutions are introduced into the environment. Both K^+ and Li^+ could depolarize the nerve, in a time varying from 5 to 35 minutes. It was possible to obtain an impulse from the depolarized, K^+ treated nerve upon treatment with Na^+ but not with Li^+ treated nerve. The most significant difference in the data appeared between the normal groups and those treated with K^+ for 20 minutes. The velocity of the nerve impulse was found to be approximately 17 meters/second. This figure does not agree with observations made by other researchers.

Twenty minutes was the time required for K^+ to diffuse across the epineurial membrane. This time period agrees favorably with the observed time for the effects of K^+ exposure to become apparent.

PARTIAL PURIFICATION OF β -HYDROXY- β -METHYLGLUTARYL COENZYME A REDUCTASE. Carole M. Nobleg, Kenneth E. Guyer, and Kenneth S. Rogers, Dept. of Biochemistry, Med. Col. of Va., Va., Commonwealth Univ., Richmond, Va., 23219.

β -hydroxy- β -methylglutaryl coenzyme A reductase from baker's yeast has been purified 50 fold from a crude preparation. Based on elution of enzyme activity from a molecular sieve column (Bio-Gel P-200), a molecular weight of 188,000 and a Stokes radius of 5.79 μm were calculated. (Aided by NIH grant HE 11768)

PARTIAL PURIFICATION OF BOVINE SULFATION FACTOR. J. P. Liberti, Dept. of Biochemistry, Med. Col. of Va., Richmond, Va., 23219.

A method for the partial purification of sulfation factor (S. F.) from bovine serum utilizing the techniques of ultrafiltration and molecular sieve chromatography is presented. The method is simple and approximately 50% recoveries of the initial S. F. activity have been consistently obtained. A 400-fold purification is obtained when the potency is based on biuret reactive material; on a dry weight basis, a 125-fold purification. From the data presented herein, it appears, that serum S. F. is similar in size to the muscle S. F. of Hall but considerably smaller than that reported by others. It is suggested that freezing and thawing of the samples prior to and during the purification procedures may dissociate S. F. from a large protein or macromolecule which would lead to artificially high molecular weight assignments

THE EFFECT OF 1-NOREPINEPHRINE ON THE FACILITY OF OUTFLOW IN NORMAL AND BUPHTHALMIC RABBITS. Van B. Noah* and W. J. Geerets*, Dept. of Ophthalmology, Med. Col. of Va., Richmond, Va., 23219.

To discover pharmacologic agents useful in lowering the elevated intraocular pressure (IOP) of glaucomatous eyes has necessitated an accurate comprehension of aqueous dynamics of the eye. The one parameter found as the most important in these evaluations has been the facility of outflow (C) of aqueous humor from the eye, not discounting, however, the significant influence of other factors, e.g., ocular rigidity, rate of aqueous production, and episcleral venous pressure.

Since 1948 a relationship between the sympathetic nervous system and aqueous dynamics has been realized. The fact that post-ganglionic sympathectomy reduced the IOP has been explained as a loss of ocular beta activity as well as an excessive release from the degenerating iritic nerve endings of alpha-active mediators which apparently affect the trabeculum and thereby increase C. It was no surprise, then, that the alpha-active agent, 1-norepinephrine, was shown to lower the IOP in normal eyes and in those with primary open angle glaucoma. The question as to whether the buphtalmic eyes of congenital glaucoma might respond favorably to this drug was the subject of this study. Intracameral injections were made into normal and buphtalmic rabbit eyes. Pre- and post-injection decay curves were manometrically recorded and mathematically analyzed. Norepinephrine was found to significantly increase C in normal eyes but not so in buphtalmic eyes. This observation tended to strengthen the concept of an absent or functionless trabeculum in buphtalmic eyes.

INTRINSIC INNERVATION OF THE URINARY BLADDER OF THE TREE SHREW (TUPAIJA) AND THE BUSHBABY (GALAGO). J. E. Norvell and D. E. Haines*. Dept. of Anatomy, Med. Col. of Va., Richmond, Va., 23219.

The intrinsic innervation of the mammalian urinary bladder was studied in the lesser bushbaby and tree shrew using histochemical techniques for norepinephrine and acetylcholinesterase (AChE).

AChE-positive cell bodies were observed in distinct ganglia in the adventitia of the bladder wall, and a few cell bodies, associated with nerve trunks, were scattered throughout the muscularis. The muscularis of the bladder wall in both *Tupaia* and *Galago* were richly innervated by AChE-positive fibers. In the lamina propria, these fibers formed subepithelial plexuses.

In *Tupaia* adrenergic cell bodies were noted at the junction of the muscularis and lamina propria and in the lamina propria itself. No adrenergic cell bodies were observed in the bladder wall of *Galago*. In *Galago* adrenergic fibers in the muscularis appear to be associated primarily with blood vessels. In *Tupaia* they appear also to be distributed to the cells of the muscularis. In both animals these fibers leave the blood vessels to enter the lamina propria where they form distinct subepithelial plexuses. The *Galago* and *Tupaia* share certain similarities with primates and other mammals relative to the intrinsic innervation of the urinary bladder. (Supported in part by A. D. Williams Grant No. 3558-510).

WHOLE ORGAN CULTURES OF FETAL MOUSE OVARIES. A LIGHT AND ELECTRON MICROSCOPIC STUDY. D. L. ODOR, Dept. of Anatomy Med. Col. of Va., Richmond, Va. 23219.

Fetal mouse ovaries obtained on day 16 of gestation were cultured on agar strips in dishes containing a modified Eagle's medium. For light microscopy organ cultures taken between 2 and 45 days after explantation were serially sectioned and stained with PAS and hematoxylin. Cultures were prepared for electron microscopy between 2 and 89 days. Zone pellucide formation was noted by day 4 of culture. Between 7 and 24 days many medium and large-sized oocytes exhibited normal ultrastructure and relationship to follicle cells. Later, although light microscopic images of the oocytes appeared normal through 37 days, the fine structure usually showed alterations, first in the follicle cells and their relationship to the oocyte and then to a lesser extent in the oocytes. A few quite normal small oocytes were seen between 70 and 89 days. Up to about 30 days the largest oocyte lay toward the center and the smaller at the periphery of the culture. Follicles matured to the unilaminar stage, but a few bi- and trilaminar ones were observed. Degenerating small and medium-sized oocytes were found most often during the first 15-20 days, while atresia of larger ones predominated after 30 days. Although the above generalizations can be made, it should be noted that there is considerable variation in structure between 2 or more ovaries cultured for the same length of time.
(Supported by NIH grants HD-00606, HD-04827 and GM-11396).

A MODEL FOR DRUG MOVEMENT ACROSS THE SALIVARY EPITHELIUM. J.W. Putney, Jr.* and J.F. Borzelleca, Dept. of Pharmacology, Med. Col. of Va., Richmond, Va. 23219

The partitioning of weak organic acids and bases between two aqueous compartments of different pH separated by a lipid interphase can be theoretically described by the Jacobs' equation (Jacobs, 1940). In an attempt to ascertain the obedience of the blood-saliva system to this model, salivary/plasma concentration ratios (S/P) of salicylic acid (a weak acid) were determined following elevation or depression of blood pH by the infusion of NaHCO₃ or HCl respectively. Since the infusions altered the pH of blood to a greater extent than salivary pH, the predicted ordering of steady-state S/P was: depressed blood pH > controls > elevated blood pH. Experimentally, however, the order was found to be the reverse. Burgen (1956) has shown that the salivary basal membrane appears to present a highly porous boundary to the diffusion of non-electrolytes. Thus it is implied that diffusion across the apical membrane is the rate-limiting lipidoidal barrier and pH dependence will occur here. Infusion of saline or glucose had no effect on the pH of any of the fluids or on the steady state S/P ratios. However, all infusions (saline, glucose, NaHCO₃, or HCl) appeared to increase the permeability of the gland to salicylic acid. This is suggestive of a dependence of glandular permeability on the state of hydrolysis of the animal. (Supported in part by U.S. Navy Contract N-00014-68-A-0510).

FURTHER STUDIES ON THE PINNER-ETARD REACTION AS RELATED TO THE METABOLISM OF NICOTINE. Margaret M. Rich*, Roger H. Meacham, Jr., Edward R. Bowman, and Herbert McKennis, Jr., Dept. of Pharmacology, Med. Col. of Va., Richmond, Va. 23219.

Nicotine reacts with benzoyl chloride or acetic anhydride with ring-opening to yield a metanicotine derivative (Pinner-Etard Reaction). The reported isolation of dihydro-metanicotine as a metabolite of nicotine in the rat prompted a renewed interest in the Pinner-Etard reaction as a possible route to dihydrometanicotine. Several fluorinated N-acyl derivatives of metanicotine were prepared via a modification of the Pinner-Etard reaction [McKennis, H., Jr., Srivastava, S. C., and Bowman, E. R., *Va. J. Sci.*, **18**, 200 (1967)]. These compounds are suitable for gas chromatographic identification using an electron-capture detector. Dansyl chloride (1-dimethylaminonaphthalene-5-sulfonyl chloride) has been reacted with nicotine to yield a fluorescent dansylmetanicotine derivative. Preliminary investigations have shown the intensity of the fluorescence of the dansyl derivative to be suitable for application in a fluorometric analysis. These two techniques, electron-capture gas chromatography or fluorometric analysis, would provide increased sensitivity over existing methods of determination.

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A DISCUSSION AND DEMONSTRATION OF THE USES OF COUNTER CURRENT DIALYSIS. Charles H. O'Neal, Dept. of Biophysics, Med. Col. of Va., Richmond, Va. 23219

Thin film dialysis has been used for some time to increase the rate of dialysis of various materials across visking membranes. In the last year a commercial device has become available for laboratory use incorporating the principle of counter current flow. Such devices have been used for routine rapid dialysis, binding studies and examination of conformational changes in peptides and proteins. A further use of this instrument is automated assays for reactions incorporating dialysable molecules into non-dialysable products.

A device made by Otto Post and Co. will be demonstrated and the above applications discussed. Clearances with this instrument are 10⁸ dpm to 10² for tritiated H₂O, complete for some amino acids and 99% for bacitracin (mol. wt. 1420). (A number of studies discussed were performed in the laboratory of Dr. Lyman Craig with the help of Dr. H. C. Chen at Rockefeller University)

CYTOXAN EFFECTS ON EPIDERMAL LANGERHANS CELLS. Willie M. Raeme, Jr. and Peter P. Greco,* Dept. Biology, Univ. of Richmond, 23173 and Div. Dermatology, Med. Col. of Va., Richmond, Va. 23219

Epidermal Langerhans cells (ELC) have been shown conclusively to be of a separate lineage from that of pigment cells. Some workers have speculated that the ELC are derived from mesenchyme and are related to certain blood cell types. In an attempt to test this possibility, Cytoxan brand of cyclophosphamide was administered to several series of mature mice over a four week period. When counts of peripheral blood showed a severe leukopenia and granulocytopenia, the animals were narcotized, the hair removed with a commercial depilatory, and skin samples taken. The skin samples were prepared either for electron microscopy or treated histochemically by the ATPase method for the demonstration of ELC.

The ATPase method showed a normal population of dendritic ELC in all samples checked. Electron microscopic examination confirmed that ELC with the characteristic granule were present. As induced changes in the leucocyte population do not affect the ELC density, it is proposed that the ELC do not arise from leucocytic contributors. (Aided by PHS grants AM-0-5508 and AM-11864. This study was done in part at the Virginia Institute for Scientific Research.)

AN INERT LIQUID MARKER FOR DENSITY GRADIENT ULTRACENTRIFUGATION IN CsCl. Alfred J. Richard, Janet Glick*, and Rosalind Burkart*. Dept. of Chemistry and Pharmaceutical Chemistry, Med. Col. of Va., Health Sciences Div., Va. Commonwealth Univ., Richmond, Va., 23219

An inert perfluorodated liquid (FC-78) has been found, that may be used as a density marker during density gradient centrifugation of DNA in CsCl. The isothermal compressibility of FC-78 at 25°C has been measured at pressures up to 280 atmospheres.

CORTICOSTERONE AND CERULOPLASMIN LEVELS IN BLOOD PLASMA OF STRESSED ANIMALS. D. H. Rowan* and G. Colmano, Dept. Vet. Sci., Va. Polytechnic Inst., Blacksburg, Va. 24061.

It has been shown that animals under stress have a rise in blood plasma corticosterone followed by a rise in ceruloplasmin. Unless there is a continuous source of stress, which may be simulated by a continuous I.V. administration of ACTH, the stressful event which affects the corticosterone rise does not last longer than 2 hrs; however, the ceruloplasmin rise that may be also simulated by a single injection of ACTH, increases slowly over a period of 24 hrs, continues to stay at a high level for 48 hrs, and then fades slowly within a week. Fourteen 42-45 day old rabbits formed an unweaned control group and fourteen experimental animals formed a mildly stressed weaned group. All animals were bled once, the experimental group was then weaned, and finally all animals were bled again 48 hrs later. As expected, blood plasma determinations showed a fall in corticosterone and a rise in ceruloplasmin level at 48 hrs in the weaned animals, while the 48-hr controls exhibited a slight, if at all noticeable, decrease of both corticosterone and ceruloplasmin. The ceruloplasmin test may be valuable to show the after effects of stress; and, after the corticosterone secretion and consequent ascorbic acid depletion has subsided, may represent the recovery time of the system.

ELECTRON MICROSCOPIC OBSERVATIONS ON PROTEIN TRANSPORT ACROSS THE VISCERAL YOLK-SAC PLACENTA OF THE RAT. W. SEIBEL and W. P. JOLLIE*. Dept. of Anatomy, Med. Coll. of Va., Richmond, Va. 23219

Exogenous peroxidase (38,900 mol wt) at 25 mg/100gm body weight was injected i.v. or into the uterine lumen on days 12, 17, and 22 post coitum. Visceral yolk sacs at varying intervals after injection (5 min to 6 hrs) were processed via a modified histochemical method of Graham and Karnovsky (1966), and were observed stained and unstained.

Uptake of peroxidase occurred by microinocytosis at sites between the apical microvilli of the endodermal cells where it had adhered to the fuzzy coated cell membrane. Peroxidase was localized in apical vacuoles, and then in an apical canalicular system. From this system, the peroxidase was condensed in larger vacuoles which were subapical but supranuclear in position. Uptake was observed to a greater extent on days 12 and 22 post coitum, than on day 17. Two to 6 hrs after injection, the larger vacuoles showed evidence of vacuolization (hydrolysis?). The 22-day visceral yolk sacs at 6 hrs post injection had small dense vacuoles localized in the basal portion of the cell in close association with the vitelline capillaries.

The results suggest that protein is transported into the vitelline capillaries across the endodermal cells at the end of pregnancy. (Aided by NIH Grant 7R01 HD04633-01)

THE DEMONSTRATION OF PLASMIN AGGLUTINATORS IN HUMAN SERA. Marion Waller and Nellie Curry*, Div. of Connective Tissue Dis., Med. Coll. of Va., Richmond, Va. 23219

Plasmin agglutinators are natural IgG anti-Fab antibodies. These antibodies bind to erythrocytes which are coated with the Fab fragments of anti-Rh antibodies that have been hydrolyzed with plasmin. The plasmin agglutinators are demonstrable in most human sera albeit in low titer. These agglutinators can be inhibited with Fab fragments that have been hydrolyzed with subtilisin, bromelin, trypsin, and plasmin but cannot be inhibited by Fab fragments from pepsin, ficin, chymotrypsin, papain or elastase digests.

The Fab fragments from naturally fragmented immune serum globulin gave identical inhibition reactions to those produced by plasmin hydrolysis.

FURTHER STUDIES ON THE PINEAL-GONADAL INTERRELATIONSHIPS IN SINGLE AND PARABIOSED GOLDEN HAMSTERS. Hugo R. Seibel, Dept. of Anatomy, MCV, Richmond, Virginia 23219

In recent years, there has been a marked increase in the number of studies of the pineal complex in an attempt to elucidate its physiology and its role as a gland of internal secretion. A new era of investigation was ushered in when Kitey and Altschule reviewed pineal physiology in 1954 and helped to stimulate research on the pineal gland.

We have previously reported that ablation of the pineal results in an increase in testicular weight; bilateral enucleation results in pineal hypertrophy and gonadal atrophy. These results were obtained in single animals and the purpose of this study was to evaluate the previously used experimental conditions in parabiosed animals.

The following groups were examined in parabiosed male and female animals: (1) both animals normal; (2) both animals bilaterally enucleated; (3) both animals bilaterally enucleated and pinealectomized; (4) one animal blinded and the other normal; and (5) one animal blinded and pinealectomized and the other normal. All animals were sacrificed from 4-6 weeks after the start of the experiment. Weight of testis, seminal vesicles, adrenals, pituitary, uterus and ovaries served as parameters.

Preliminary results suggest that bilateral enucleation activates the pineal gland to secrete a substance(s) which modifies the hypophyseal-target organ axis in both single and parabiotic animals. The above results will be discussed. Supported by Grant 3558 (355). A. D. Williams, MCV

MEASUREMENT OF THE QUALITY (EFFECTIVE ENERGY) OF X RAYS USED IN DIAGNOSTIC MEDICAL PROCEDURES. E. E. Stickley, Radiation Physics Div., Med. Coll. of Va. Richmond 23219

Control of the specific energy of x rays incident on the patient and reaching the recording medium is important in achieving the best diagnostic quality of medical roentgen images. Physical measurements in the laboratory can characterize these radiations with precision and can even determine the ability of radiologic systems or their components to handle the information in the radiation pattern. In the clinical situation, however, laboratory equipment cannot be used routinely; in its place a set of simple and rapid measurements is made with easily portable devices. Ionization chamber determinations of radiation output (roentgens per mAs or per minute) and quality (half-value-layer in aluminum) are still essential. In addition, the effective energy (electron-volts equivalent) is determined quickly in terms of mass absorption coefficient in copper or aluminum. A special cassette provides comparison scales on film from single exposures at each setting of the x-ray machine controls. Selected intensifier screens and finely adjusted step-wedges are used to suit both high and low energy medical x-ray regions. Reference numbers represent the quality of the radiation; calibration against a standard source may be made. Improved control and better protection are gained since minimum radiation exposure for maximum diagnostic information can be established.

Section of Microbiology

Forty-eighth Annual Meeting of The Virginia Academy of Science
May 6-8, 1970, Richmond, Virginia

THE EFFECT OF ACTINOMYCIN D ON THE REPLICATION OF RESPIRATORY Syncytial (RS) VIRUS. J. V. Formica*, Dept. of Microbiology, Med. Col. of Va., Richmond, Va. 23219

Following infection of HeLa monolayer cultures with RS virus, replication was found to be inhibited from 70 to 99.9% in the presence of actinomycin D (Act D) ranging in concentration from 0.1 to 2.0 $\mu\text{g}/\text{ml}$, but was unaffected by inhibitors of DNA synthesis. The time-course of uridine- C^{14} incorporation into RNA was measured in infected cells in the presence of Act D (0.1 and 0.25 $\mu\text{g}/\text{ml}$). At these concentrations of Act D, virus yield was 10 and 20% of control values while uridine- C^{14} uptake into cellular RNA was depressed 60 and 80% respectively; preincubation of the cells for 2 hours at these concentrations of drug prior to infection did not depress replication further. The addition of drug (0.1 or 1.0 $\mu\text{g}/\text{ml}$) at various times after infection did not reveal a critical point in the replicative cycle; however, RNA was synthesized at a constant rate between the fourth and eighth hour post-infection in the presence or absence of drug.

THE EFFECT OF AN EXTRAGENIC MUTATION ON THE L-RIBULOkinASE GENE OF ESCHERICHIA COLI B/r. W. S. May, Jr.,* and R. M. Cribbs, Dept. of Genetics, Med. Col. of Va., Richmond, Va. 23219

The araB gene of the L-arabinose operon is the structural gene for L-ribulokinase. A mutant of the araB gene, araBl4L, does not produce a functional kinase and has a polar effect on the adjacent araAB gene, the structural gene for L-arabinose isomerase. A spontaneous partial revertant (araBl4RL) has been isolated from araBl4L. The partial revertant has a higher level of both kinase and isomerase than the araBl4L mutant. These levels are not as high as those of the wild type. The presence of a suppressor mutation, S^{B} , which is unlinked to the araB gene, increases both kinase and isomerase levels of the araBl4L: the kinase to a level below, and the isomerase to a level equal to, that of the wild type. Kinetic studies were carried out with the kinase from the wild type, partial revertant, and the suppressed partial revertant. The results indicated that the wild type kinase is different from that of the two mutants, while the kinase of the partial revertant is the same as the kinase of the suppressed revertant. These data indicate that the suppressor mutation acts to increase the amount of kinase, probably by increasing the rate at which the araB gene containing the araBl4L mutation is translated and also completely relieves the polarity imposed on the system by the araBl4RL mutation. Supported by NIH Grant GM11098.

R FACTOR REPLICATION IN PROTEUS MIRABILIS. D. J. Kopacko and J. D. Punch, Dept. of Microbiology, Health Sciences Division, Va. Commonwealth Univ., Richmond, Va. 23219

Extrachromosomal elements carrying drug resistance loci are transmissible between many species of Gram - organisms. Previous studies have shown that upon transfer of R factor (222) from *Escherichia coli* to *P. mirabilis* (Pm-5) two distinct episomal components of densities 1.709 (50% G+C) and 1.718 g/cm³ (59% G+C) are detectable. Studies were undertaken to determine the optimal growth phase of Pm-5 for maximal R factor DNA content. Pm-5 (222) grown in Penassay broth was harvested after 24, 48 and 72 hrs incubation. Isolated DNA was subjected to isopycnic CsCl centrifugation. The percent Pm-5 DNA, 50% G+C DNA and 59% G+C DNA in each preparation was determined. Twenty-four hr cultures contained 13% R factor DNA of which the 50% G+C and 59% G+C components represented 95 and 5%, respectively. Eleven % of the 48 hr and 7% of the 72 hr preparation was R factor DNA. However, the 50% G+C and 59% G+C components represented 52 and 4% of the total R factor DNA in these preparations. From calculations based on reported molecular weights of the (222) components, 24 hr cultures contained 8 copies/genome of the 50% G+C and 2 copies/genome of the 59% G+C components, while 48 hr cultures contained 4 copies/genome of 50% G+C and 17 copies/genome of 59% G+C components. After 72 hr, only 2 copies/genome of 50% G+C and 10 copies/genome of the 59% G+C components was observed. These results suggest that the control of replication of R factor components varies with the physiological age of Pm-5.

STUDIES ON PATHOGENIC STRAINS OF NAEGELERIA. E. Clifford Nelson and Muriel M. Jones, Dept. of Microbiology, Med. Col. of Va., Richmond, Va. 23219

In the summer of 1967, 1968 and 1969, we isolated strains of an amoeba from spinal fluid and other tissues of four fatal cases of primary amebic meningoencephalitis. Culture media and methods for continued maintenance and study were devised. All four strains resemble *Naegleria gruberi*. In a program aimed to reveal the complex of circumstances leading to infection, we are comparing strains isolated from the environment with strains from cases. The origin of pathogenic strains may be revealed by a combination of culture and animal inoculation studies.

PHOTOINACTIVATION OF ACTINOPHAGES. Tina Noble* and S. G. Bradley, Dept. of Microbiology, Med. Col. of Va., Richmond, Va. 23219

The triphenylmethane dye crystal violet has been shown to photosensitize actinophages for *Nocardia* and *Streptomyces*. The present photoinactivation studies were conducted with phage MNF6, which lyses *Nocardia brasiliensis* and with phage MSP8, which lyses *Streptomyces venezuelae*. The extent of photoinactivation was determined by the crystal violet concentration, by the duration of exposure to light and by the light intensity. In addition, actinophage MSP8 suspended in acidic phosphate buffer was more susceptible to photoinactivation than samples suspended in basic phosphate buffer. Deoxyribonucleic acid, added to give a final concentration of 100 µg/ml, protected phage MNF6 from the photosensitization by 10 µg crystal violet/ml. The following nucleic acid derivatives at final concentrations of 100 µg/ml did not protect phage MNF6 against photoinactivation by 10 µg crystal violet/ml: the bases adenine, guanine, cytosine and thymine, their deoxyribonucleosides and deoxyribonucleotides. This study had developed a sensitive indicator system for photoinactivation using crystal violet as the photosensitizing agent. In phage MNF6, the deoxyribonucleic acid portion of the bacterial virus seems to be the most sensitive area for photodegradation.

NUCLEIC ACID HOMOLOGIES IN STRAINS OF LACTOBACILLI. Josephine Simonds,* P. Arne Hansen, and Sitarama Lakshmanan,* Dept. of Microbiology and Dept. of Chemistry, Univ. of Md., College Park, Md. 20742

DNA of *L. bulgaricus* ATCC 11842 was labeled with P-32 and after denaturation was hybridized with unlabeled, denatured *L. bulgaricus* ATCC 11842 DNA (homologous reaction), and with unlabeled, denatured DNA of *L. lactis* ATCC 12315, *L. jugurt* ATCC 521, and *L. helveticus* ATCC 15009. Better than 98% of the input labeled DNA was recovered double stranded in the homologous reassociation. In the heterologous reactions, no P-32 labeled hybrid was detected with *L. jugurt* ATCC 521, 3-5% with *L. helveticus* ATCC 15009, and approximately 86% with *L. lactis* ATCC 12315. The results are consistent with present knowledge of base ratios of these species.

EFFECT OF SULFUR AND SULPHYDRYL COMPOUNDS ON THE HEAT RESISTANCE OF *CLOSTRIDIUM BOTULINUM* 33A SPOROS. J. Upadhyay and M. L. Churchill*. Dept. of Microbiology, Va. State Col., Petersburg, Va. 23803

Bacterial spores contain more cysteine-rich substances than the vegetative cells. The purpose of the present investigation was to determine whether the sulfur and sulphydryl compounds play any role in the heat resistance of *Clostridium botulinum* 33A spores.

The spores were produced in trypticase medium, harvested by centrifugation, washed by lysozyme and trypsin, and heated at 100°C in different suspending menstrua. The viable cells were determined on Wynne's agar.

The results indicate that elemental sulfur provided the highest amount of protection and distilled water was least effective. Distilled water served as a control. After 30 minutes of heating at 100°C sulfur gave more than two hundred times more resistance than distilled water. Cysteine, sodium thioglycollate, cystine, and oxidized glutathione provided a little more than 100, 1, 2.5, and 1.5 times respectively more protection than the control.

The data indicate that sulfur and sulphydryl compounds play a significant role in the heat resistance of *C. botulinum* 33A spores. The compounds may be aiding in the stability of the proteins involved in heat resistance of the spores.

Section of Psychology

Forty-eighth Annual Meeting of The Virginia Academy of Science
May 6-8, 1970, Richmond, Virginia

DECREASED QUININE TOLERANCE AS A FUNCTION OF WATER DEPRIVATION. W. L. Angelo*, and E. R. Bauer*. Dept. of Psychology, The College of William and Mary, Williamsburg, Va. 23185

Jacobs and Sharma (1969) proposed that animals in a state of energy deficit induced by deprivation would be more responsive to taste than caloric value of food. However, their deprived Ss tolerated more quinine in glucose and corn syrup solutions than did ad lib. The present study adapted rats to ad lib and 23.5-hour Water deprivation with ad lib food, and tested tolerance of increasing amounts of quinine hydrochloride in drinking water. Test days alternated with three days of plain water. Quinine adulteration started at .005% and increased by .005% on each successive test. The deprived Ss stopped drinking when water was adulterated with .205% quinine; the ad lib group was ingesting a .305% quinine solution at the end of the study. These results showed that when tolerance of quinine was not confounded by forcing approach-avoidance conflict with solutions containing calories and sweet taste, as well as bitter flavor, deprived rats were more sensitive to qualitative aspects of the water than were ad lib Ss. The present study did not present increasingly stronger quinine solutions on consecutive days, but used repeated, discontinuous tests. Both groups ingested more water on the first day after tests, especially at higher concentrations of quinine, but even after 200 days on the 1-3-1 test schedule neither group showed acquisition of the anticipatory response of increased water intake on the day immediately preceding a test.

THE DELINEATION AND APPLICATION OF THREE MNEMONIC TECHNIQUES IN THE RETENTION OF VERBAL MATERIAL. Charles E. Boltwood* and Kenneth A. Blick. Dept. of Psychology, Univ. of Richmond, Va. 23173

An experiment was performed in order to determine what mnemonic techniques subjects (Ss) would employ in learning and remembering a list of 19 conceptually and superficially unrelated nouns with low frequency of occurrence. Primarily, Ss used what experimenter (E) termed the "descriptive story technique," "first letter technique," and "clustering technique."

In a second experiment E wished to ascertain which of these techniques would prove most effective in Ss' immediate, 1-week, and 8-week recall of the 19 words. Each of three experimental groups was instructed to use a different one of the three mnemonic techniques. The control group was told to use the "simple repetition technique," which involves merely reading over the words repeatedly. There was no significant difference among the groups' recall at the immediate retention interval. The "descriptive story technique" resulted in significantly better 1-week and 8-week recall than that of each of the other groups. The "clustering technique" was better than the "simple repetition technique" for 1-week recall. E concluded that while no mnemonic technique improved memory for immediate recall, the "descriptive story technique" facilitated 1-week and 8-week recall better than did any of the other techniques.

TRANSITIONAL ADAPTATION AT LOW LUMINANCES. A. N. Beare* and E. J. Rinalducci. Dept. of Psychology, Univ. of Va., Charlottesville, Va. 22901

Visibility losses accompanying a sudden change from one prevailing luminance level (B_1) to a new level (B_2) were investigated for low luminances.

Five subjects were run in a three-channel free-viewing apparatus. Test-letter flashes of 50 msec. duration and subtending 10.6 min. at the eye were superimposed on a 14 x 18 deg. background field. The luminance level change was 600 msec. in duration. B_1 was always 0.02 fL, while B_2 was 0.0002, 0.002, 0.2 or 2.0 fL. Stimulus-onset asynchrony was varied from -100 to +400 msec. A forced-choice technique with knowledge of results was used in conjunction with the "up and down" psychophysical method.

The 10- and 100-fold decreases in prevailing luminance level produced negligible losses in visibility. Visibility loss was indicated, however, for the 10- and especially the 100-fold increase in luminance.

Previous investigations of changes at higher absolute luminance levels tend to show equivalent visibility losses regardless of direction of change; this does not appear to be the case for very low luminances.

HARMONIC AND INHARMONIC RELATIONSHIPS AND THE PERCEIVED LOUDNESS AND ANNOYANCE OF NOISE. Ann B. Carroll*. Dept. of Psych., Col. of Wm. & Mary, Williamsburg, Va. 23185

Twenty-four Ss judged a series of complex sounds (half of which were harmonic and half of which were inharmonic in relationship) for loudness and for annoyance using a paired comparison method. One-half the stimuli had logarithmic tone centers (LTC) lower than that of the standard. All of the sounds were judged without white noise and half of them were judged with white noise at four intensity levels. Ss were asked to state the number of tones they heard in each complex. One form of the Polygon Preference Test was given to all Ss to measure preference for complexity.

Inharmonic sounds, without white noise, were heard as louder and more annoying than harmonic sounds. A change in frequency between standard and comparison stimuli does not affect loudness judgments but low frequency comparison stimuli are perceived as less annoying than high frequency comparison stimuli. At -20 db. white noise reduces perceived loudness below that of the no white noise condition, but heightens the perception of annoyance. White noise, at -20 db. reduces the difference between harmonic and inharmonic complexes for both loudness and annoyance.

Ss heard more tones in inharmonic complexes than harmonic complexes. Generally, there were no significant differences between groups but changes in LTC of comparison stimuli, relative to the standard, primarily affected the low preference for complexity group.

TASTE WITH- AND WITHOUT-GUSTATION PREFERENCES OF COLA BEVERAGES. N. M. Cummings*, and F. S. Murray. Dept of Psychology, Randolph-Macon Woman's Col., Lynchburg, Va. 24504

Taste preferences of six colas were tested with- and without-gustation. Twenty Ss were tested with the paired comparison method. Questionnaires on cola consumption habits and brand preferences were also obtained. The results showed: (a) preferences for cola beverages ($p < .001$), (b) correlation between taste with- and without-gustation was highly significant ($r = .87$, $p = .01$) and (c) a significant time-error effect in the taste with gustation condition.

VARIATION OF REPETITION IN SHORT-TERM MEMORY. M.H. Garskofk*, Dept. of Psychology, Mary Washington Col., Fredericksburg, Va. 22401

Two experiments were done to investigate the effect of variation of repetition in short-term memory. In the first experiment categories were repeated by having the same, a conceptually similar or a conceptually different instance of the category follow immediately in a short-term memory situation. Retention of the generic categories was significantly greater with the similar and different than with the same specific stimuli.

In the second experiment the two repetitions of the categories were never contiguous. Retention interval (3, 11, or 25 sec.) and spacing condition (0 or 8 sec. of number classifying) were also varied. Category recall increases as a function of spacing and decreased as a function of retention interval. Greater spacing improved category recall for same items and decreased category recall for different items but category recall for similar items remained about the same. Thus, the effect of spacing a repetition and the effect of varying a repetition interact. These effects and their interaction are attributed to variability in encodings during the presentations.

EFFECTS OF STOMACH LOADING A HYPERTONIC NaCl SOLUTION ON FOOD INTAKE IN ADULT AND WEANLING RATS. Frederick J. Kozub. Dept. of Psychology, Univ. of Richmond, Richmond, Va. 23229 When subjected to a 5.0% body weight stomach load of 6.0% NaCl, adult male and female rats increase their water intake in response to this osmotic stress. Adult male rats, however, decrease their food intake and lose weight; female rats do not. The mechanism responsible for this phenomenon seems to involve progesterone and estrogen as ovariectomized rats behave like males. The young rats (28 days of age), male and female, although lacking in adult sex hormones behave like the adult female in response to the NaCl stress. Thyroidectomized young rats, (male and female), however, decrease their food intake and lose weight in response to the NaCl stress. It seems then, that there may exist different hormonal controls over blood tonicity and volume regulation in response to NaCl induced stress at different ages in the rat. Possible mechanisms of hormonal control over adrenal-kidney-blood tonicity and volume regulation are discussed.

GENERALIZATION OF INDICATOR NEEDLE POSITION IN THE PIGEON. Ricardo Dobson*, Dept. of Psychology, Mary Washington College of the University of Virginia, and THOM VERHAYE*, Dept. of Psychology, Queen's University of the City University of New York

Zimmerman and Ferster have demonstrated that the position of the indicator needle of a volt meter can be used as a discriminative stimulus with pigeons. The technique appears to have promise for use in studies of stimulus control and conditioned reinforcement. In the present study, our main purpose was to obtain generalization gradients with a small number of birds. We also explored changes in the gradients due to different ranges of stimulus settings with a maintained generalization paradigm.

It was shown that it is possible to determine a generalization gradient in pigeons to the position of a needle on a meter. Furthermore, the hyperbolic form of the generalization gradient appears similar to that obtained by Pierrel with rats on an auditory intensity dimension. The decline in the proportion of responses emitted to a stimulus paired with reinforcement was found to be a joint function of absolute and relative stimulus properties. The gradients obtained with needle position as the test continuum resembled those obtained with more traditional continua in the form of the gradient and in the multidimensional nature of the control exerted upon the gradient.

SUPPRESSION OF THE GALVANIC SKIN RESPONSE BY COGNITIVELY MEDIATED BEHAVIOR. William G. Hughes*, and Glenn D. Shean*. Dept. of Psychology, Col. of William and Mary, Williamsburg, Va. 23185

The effects of external feed back and awareness of reward contingency upon the ability to voluntarily suppress a conditioned GSR were studied in 21 high neurotic introverted and 21 low neurotic extraverted Ss selected on the basis of the Maudsley Personality Inventory. A conditioned GSR was established by 5 classical pairings of a CS (signal lamp) and a UCS (aversive electric shock). On subsequent presentations of the CS Ss were required to maintain their GSR below 5000 change on 5 consecutive trials in order to receive reward (cessation of shock). Ss were instructed to suppress their GSR by employing cognitive manipulations such as "thinking relaxed thoughts."

Results showed that Ss who were aware of the reward contingency and who received appropriate positive or negative feedback after each trial were able to reduce their GSR over 20 test trials significantly more than the control group and a group which was aware of the reward contingency but received no feedback. A second finding was that introverts were significantly more successful on this task than extraverts. This result was interpreted as support for Eysenck's theory that introversion is characterized by cortical excitation while extraversion is characterized by cortical inhibition.

REINFORCEMENT IMMEDIACY: AN ANALYSIS OF EFFECTS OF TERMINAL LINK FIXED-LINK AND VARIABLE-INTERVAL SCHEDULES. David MacEwen. Mary Washington Col. of the Univ. of Va., Fredericksburg, Va. 22401

Prior work using variable-interval schedules in the terminal links of the concurrent chain procedure suggested that relative rate of responding in the initial links equalled relative rate of reinforcement in the terminal links. With fixed-interval terminal schedules, this matching was not obtained.

The present study used FI terminal link schedules in a constant ratio but variable absolute sizes. Relative rate was a negatively accelerated, positive function of absolute size of the fixed-interval pairs. At fixed-interval pair 5-10 sec, matching was found. When variable-interval schedules were used, constructed so that the harmonic mean of the intervals equalled the fixed-interval pairs, relative rate function duplicated those for fixed-interval schedules.

The matching relation is not a general phenomenon, but is simply a point on a continuum and as such can not be thought of as a rule of behavior at all.

Further analysis revealed that the absolute differences between harmonic means of the terminal schedules were the main determinant of relative rate and that a contrast or interaction effect existed between terminal schedule pairs.

A TEST OF THE LETTER-SEQUENCE HYPOTHESIS WITH RESPONSE FREQUENCY HELD CONSTANT. Ann Marie Pearson*, Dept. of Psychology, Univ. of Lynchburg, Va. 23173

By the self-paced learning procedure two groups of 30 Ss were trained and tested for immediate recall of the response terms in a paired-associate task. Each list consisted of six stimulus bigrams paired with single-letter associates. From the norms of Underwood and Schulz (1960), lists of high (.21) and low (.01) response associative probability were derived. The response items were the same for both lists, thereby holding response frequency constant.

The high associative list was learned in a significantly shorter period of time (54.9 sec.) than the low associative list (86.6 sec.). The difference in learning time reflects the interaction of extra-experimental interference due to letter-sequence habits which produce powerful effects in the low associative list. These data provide additional support for the letter-sequence hypothesis advanced by Underwood and Postman (1960).

EFFECTS OF RATIOS OF REWARD AND DIFFERENTIAL START CUES ON RUNNING SPEED. M.E. Redford and R.G. Seymann, Dept. of Psychology, Lynchburg Col., Lynchburg, Va. 24504

Although it is a generally accepted psychological rule that runway speeds are proportional to magnitude of reward, such an effect is not always obtained. A review of the literature concerned with contrast phenomenon suggests that differential running speeds obtained to two different reward conditions may be a function of both the ratio of large to small ($S^+ : S^-$) rewards and the duration of available reward correlated cues prior to the initiation of the running response. The present experiment was designed to investigate the joint effects of these variables. Forty-eight Ss were randomly assigned to one of 12 treatment conditions in a 3×4 design with three $S^+ : S^-$ ratios (2:1, 4:1, and 8:1) and four reward correlated start box cue durations (0, 9, 27, and 81 sec.). Alley and goal box brightnesses were correlated with reward magnitude for all groups. Start box brightnesses were correlated for the 9, 27, and 81 sec. groups. Ss received 10 trials per day for 16 days. Half of each S's daily runs were to S^+ and half to S^- . The results support the hypothesis that differential running speeds are a function of $S^+ : S^-$ ratio and pre-run cue availability.

THE EFFECT OF PUBERTY ON THE YIELDING BEHAVIOR OF JUNIOR HIGH SCHOOL CHILDREN. E.C. Sale*, M.L. Dixon*, and T.L. Pasternack, Dept. of Psychology, Randolph-Macon Woman's Col., Lynchburg, Va. 24504

This study was concerned with finding qualitative differences relative to puberty in the yielding behavior of children in the 6th-9th grades.

The "naive majority" technique was used with the Visual Judgment Scale on 96 six-student groups to determine whether the yielding behavior of the critical subjects was compliance or true conformity. The basis of the yielding of the critical subjects who had reached puberty was compared with that for those who had not yet reached puberty, as determined by their responses to a questionnaire.

Although none of the findings was statistically significant, the following trends were observed: (a) girls in these grades were more compliant than boys; (b) girls exhibited compliant behavior at an earlier age than boys, and (c) both sexes were more compliant after reaching puberty.

REDUNDANT ELEMENTS AND ACOUSTIC SIMILARITY IN SHORT-TERM MEMORY. R.A. Smallwood*, Dept. of Psychology, Univ. of Richmond, Richmond, Va. 23229

Each of 32 Ss recalled 160 memory series composed of 8 consonant letters, 40 series each under control (C) response prefix (RP), stimulus suffix (SS) and modified stimulus suffix (MSS) conditions. In each memory series, half the letters over a series of 40 trials were acoustically similar (S), from the subset BCDFGPTVZ, and half were acoustically neutral (N), from the subset HLJNRKQY. Each letter from subset S was represented as a redundant element 5 times in the RP, SS, and MSS conditions for half the Ss, and each letter from N was represented in the same manner for the other half. The redundant elements in the MSS condition were separated from the memory series by 3 spaces and typed in lower case.

It was predicted that performance would be facilitated in the MSS condition. In addition, an account of the prefix effect (PE) based on retroactive inhibition predicts that S redundant elements should disrupt recall more than N elements, and the difference between the PE of S and N elements should be larger in performance on the BCDFGPTVZ subset than the HLJNRKQY subset. Contrary to past research, the predictions based on the MSS condition and the PE failed to receive support by these data. Implications to a perceptual model of information flow in immediate memory, along with theories of organization in short-term memory are discussed.

THE EFFECTS OF FREQUENCY AND DURATION ON THE PERCEPTUAL ATTRACTION OF UNFAMILIAR STIMULI. K.M. Stanton*, and F.S. Murray, Dept. of Psychology, Randolph-Macon Woman's Col., Lynchburg, Va. 24504.

Zajonc's (1966) hypothesis was tested that an individual's attitude toward an unfamiliar stimulus is enhanced by mere repeated exposure to that stimulus. Twelve Chinese-like characters from Hull's concept formation study were shown with frequencies and durations of 2, 4, and 8 times and seconds respectively. The total exposure time for the frequency and duration groups were equal. Sixty undergraduate females judged these stimuli on a 7-point evaluative scale. Results failed to confirm Zajonc's hypothesis, however an exposure effect was suggested: 7 out of 12 characters in the frequency condition had a higher mean rating for 8 exposures than for the lesser exposures and 6 out of 12 characters had the same effect in the duration condition. Failure to confirm Zajonc's hypothesis was attributed to exposure range (Zajonc used 0, 1, 2, 5, 10 and 25) and instructional set.

THE EFFECT OF SUBJECT AND EXPERIMENTER VARIABLES UPON SUPPRESSION OF THE GALVANIC SKIN RESPONSE. A.A. Turnbull, Jr.* and W.G. Hughes*, Dept. of Psychology, Col. of William and Mary, Williamsburg, Va. 23185

In an attempt to delineate some important subject and experimenter factors affecting a psychophysiological task, voluntary suppression of a conditioned galvanic skin response (GSR) of 40 college students was recorded as a function (1) S's sex (2) induced instructional set (hard vs. easy), (3) experimenter's behavior (pleasant vs. unpleasant) and (4) S's personality (introversion vs. extraversion). The onset of the CS (white light) always preceded the UCS (electric shock) by 6 sec. Ss were instructed to keep their conditioned autonomic nervous system (ANS) activity as low as possible.

A significant ($p < .025$) main effect for sex revealed lower GSRs for females than males. An interaction between E's behavior and S's personality revealed that introverts suppressed their GSR better when E was unpleasant than when he was pleasant. The reverse was true for extraverts ($p < .005$). Two significant higher order interactions were found such that extraverted males and females performed better when E was pleasant and also when the instructional set was easy. Female introverts performed better when E was unpleasant, and male introverts performed better when the instructional set was hard.

EFFECTS OF NOVEL STIMULUS DEPRIVATION ON ONSET OF FIRST REM SLEEP PERIOD. J. Catesby Mars Jr.* and Robert Schopp*, Col. of William and Mary, Williamsburg, Va. 23185

It was hypothesized that REM sleep was necessary to compensate for lack of novel stimulation prior to REM sleep; if so, reduction of novel stimulation before sleep would be expected to reduce the amount of NREM sleep before REM sleep.

The 2 Ss (the 2 Es) each went through a novel stimulus deprivation period (NSD) by remaining in a small experimental room for 8 hours before going to bed. They were allowed to read and study except for the last hour.

The onset of the first REM sleep period was recorded and compared to the onset after a "normal" day in which the Ss carefully avoided an excess of any particular activity or any activity in which they were alone. The onset of REM sleep was recorded for S₁ after 2 "normal" days and 1 NSD day and after 1 "normal" and 1 NSD day for S₂. Both Ss spent 1 adaptation night in the recording lab with EOG, EEG, EMG, and ERG electrodes attached, but no recordings were made until test days.

Onsets for REM sleep after "normal" days were 123, 121, and 118 minutes after sleep onset. For the 2 deprivation days onsets were 83 and 76 minutes.

A study with more Ss is planned to correct for the possibilities that 1) Ss unknowingly slept during NSD, 2) Ss were able to affect REM onset by knowing and being interested in the hypothesis.

RESPONSE LEARNING, ASSOCIATION FORMATION, AND REPEATED TESTING EFFECTS IN A PAIRED ASSOCIATES TASK. Roy B. Weinstein, Dept. of Psychology, Mary Washington Col., Fredericksburg, Va. 22401, and Helen B. Daly, Dept. of Psychology, S.U.N.Y. Col. at Oswego, 13126.

Paired associate (P-A) learning has been conceived of by Underwood, Rumsey, and Schulz (1959) to be composed of two separable stages, viz., response learning (Stage 1) and association formation (Stage 2). It was further posited that Stage 1 precedes, or occurs not later than, Stage 2. The primary purpose of this study was to test these assumptions. A second purpose was to examine the effects of repeated testing. That is, it was deemed desirable to see if correct-response probability would be altered by previous test occasions.

Following one, three, or seven P-A trials, subjects (Ss) were given response-recall, response-recognition, and associative matching tasks. For both high and low intralist response similarity (IRS) conditions, response learning occurred faster than association formation between stimuli and responses, thus supporting the two-stage analysis of P-A learning. High IRS groups performed, in general, poorer than low IRS groups on all three tasks. Repeated testing on the three tasks resulted in greater facilitation for the associative-matching than the response-recall task, due to previous experiences with the tasks, independent of the number of P-A trials. This indicated that between-S designs should be used to test Stage 1 and Stage 2 development.

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EFFECT OF VARIABLE THERMAL CONDUCTIVITY ON THE RESPONSE CHARACTERISTICS OF THIN FOIL HEAT FLUX SENSORS. R. L. Ash, School of Engineering, Old Dominion University, Norfolk, Virginia 23508.

A theoretical and experimental investigation has been performed to determine how variable foil thermal conductivity alters the response of thin foil heat flux sensors. The investigation has been restricted to constantan foils where variations in thermal conductivity are large in comparison with variations in the thermal diffusivity. A mathematical model has been developed based on previous work by the author, and a dimensionless parameter has been defined which predicts the variation in foil response.

Good agreement between the theoretically predicted response, and the measured response was found at low heating rates (1 BTU/ft²sec), but there was considerable error at higher heating rates (60 BTU/ft²sec).

OPTIMIZATION OF A VARIABLE GEOMETRY SUPERSONIC DIFFUSER. J. S. Bias* Dept. of Aerospace Engineering and Engineering Physics, Univ. of Va., Charlottesville, Va. 22901

When optimizing a supersonic wind tunnel one is often restricted by limitations unique to the given facility. In this investigation a super-sonic diffuser yielding maximum pressure recovery has been designed for a Mach 3 axisymmetric wind tunnel of fixed throat size and whose outside diameter is restricted to a maximum of 6 inches for a distance of 6 feet from the nozzle exit plane. The investigation is largely experimental, since available theoretical and empirical information of general validity is very scarce and can only be used to point out some of the important design parameters. A variable geometry diffuser employing a translating center body was studied. Results indicate that, relative to a fixed geometry diffuser, significant improvement in pressure recovery can be obtained. The optimized wind tunnel will be part of the Univ. of Va. Cold Magnetic Balance facility.
(Sponsored by NASA Grant NGR 47-005-029)

SOLID STATE CONSIDERATIONS AS RELATED TO THE PRODUCTION OF STABILIZED HAFNIUM OXIDE PIGMENTS FOR WHITE THERMAL CONTROL COATINGS. *V. D. Buckley*, NASA, Langley Res. Ctr., Hampton, Va. 23365

The primary cause of optical property changes of coatings is the damage induced in the pigments by radiation. The effect of solar radiation on a coated structure causes crystal defects, displacement of atoms, and when subjected to extensive exposure, destruction of the long-range structure of the crystal. One of the products of radiation damage of white coatings is migration of impurity cations to defects in the crystal lattice and subsequent formation of color (F) centers. Hafnium oxide is a very stable and inert material; however, it is known to have a defect crystal structure. In its pure form, hafnia does not produce an acceptable thermal control coating. Hafnia-calcia solid solution formulated by sintering mixtures of hafnia and calcia at $>1700^{\circ}\text{C}$ for ≥ 24 hours has produced a material free of many impurities due to oxidation of the impurities at elevated temperatures and the formation of a distorted fluorite structure due to the substitutional solid solution of the large Ca ions for the smaller Hf ions. The combined effects of (1) purging the hafnia-calcia solid solution of most of its impurities through high temperature oxidation, and (2) the effects of the $\text{HfO}_2\text{-CaO}$ distorted crystal structure in hindering diffusion of residual post oxidation impurities, has resulted in a white thermal control pigment that has excellent resistance to solar radiation damage.

DESIGN LOAD CONSIDERATIONS FOR PARACHUTES By John L. Gilbert*

A method is presented for determining loads in axisymmetric parachutes generated as a body of revolution by the main structural members. Profile shapes are calculated during the analysis with no restrictions placed on the magnitude of deflections. The equilibrium and compatibility equations are solved numerically to give load distribution in the gores and also in the primary meridional members.

The theory is not restricted to any particular flight region; the only requirement being that the pressure coefficients and dynamic pressure be adequately represented. Inertial and asymmetric loads are not considered in the derivations. Required input data consists of pressure coefficients along the meridian, dynamic pressure, and geometrical dimensions.

A comparison is made with other analytical studies and test data reported in the references.

This development represents an approximation of some of the parachute loads encountered during flight and can be of valuable assistance during the initial design stage. The analysis is similar to the large deflection membrane theory, but differs from it by having primary structural members in the meridional direction.

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SUPersonic FLOW OF NONUNIFORM FREE-STREAMS PAST WEDGES AND CONES. *F. R. DeJarnette* and *F. G. Moore**, Aerospace Engineering Dept., Va. Polytechnic Inst., Blacksburg, Va. 24061

Inviscid flow fields of supersonic nonuniform free-streams past wedges and cones are calculated by the method of characteristics. Nonuniform free-streams typical of those in the wake of a primary vehicle are considered.

An adverse pressure gradient occurred on the surface, near the nose, which could lead to boundary-layer separation. The surface pressure and shock-wave angle asymptotically approached the values corresponding to a uniform free-stream. However, the surface Mach number decreased and asymptotically approached a value much lower than that of a uniform free-stream.

It was found that the drag of a wedge or cone in a wake-like nonuniform free-stream is substantially less than the drag in a uniform free-stream.

ANALYSIS OF MERGED-LAYER REGIME ON A CONE. *W.L. Harris, Sr.* and *Santosh Kumar**, Dept. of Aerospace Engineering and Engineering Physics, Univ. of Virginia, Charlottesville, Va. 22901

The hypersonic, low density flow past a semi-infinite, sharp right circular cone at zero incidence is analyzed. Only the merged-layer regime is considered. In this regime the shock thickness and the viscous layer thickness are of the same order. The shock structure is treated within the Navier-Stokes formulation while the viscous layer regime is taken to be non-similar and of the boundary-layer type. To zeroth-order, analytical expressions are obtained for the following quantities: (1) conservation of mass flux across the viscous layer between the cone surface and the shock surface, (2) matching of normal gradients in velocity resulting from the curved shock and those resulting from the viscous layer at shock-viscous layer interface and (3) matching of velocity components and state variables at the shock-viscous layer interface. Analytical expressions are compared with corresponding results for hypersonic, low density past a semi-infinite flat plate with a sharp leading edge at zero incidence in the merged-layer regime. First order corrections for shock curvature, and velocity slip and temperature jump at the cone surface are not considered in this report. (Aid by NASA Grant NGR 47-005-014 and Grant AF-AFOSR-69-1798.)

MOMENTUM TRANSFER OF OXYGEN ATOMS TO ECHO I SURFACES AT SATELLITE VELOCITIES.* *J.A. Hoyle**, *J.W. Boring*, and *R.R. Humphries**, Dept. of Aerospace Engineering and Engineering Physics, Univ. of Va., Charlottesville, Va. 22901.

As a satellite passes through the earth's upper atmosphere a drag force is exerted upon it by the constituents of the atmosphere, primarily N_2 , He , and O . From a knowledge of the drag force (obtained from orbital decay information) and the drag coefficients due to these specific gases, the density of the upper atmosphere can be calculated. Before the drag coefficient can be determined, one must have a knowledge of the momentum transfer of these gases to the solid surface of the satellite. Momentum transfer results of N_2 on satellite surfaces have been reported earlier and this paper gives the results to-date of the investigation of momentum transfer of monatomic oxygen to an Echo I satellite surface. A monatomic oxygen beam is produced by passing an O^+ ion beam through a neutralizing gas. The neutral O beam is then allowed to strike the surface of satellite material mounted on a torsion balance. From deflections of this torsion balance the ratio of the momentum of the incident oxygen atoms to the momentum of the reflected atoms is determined. Knowing this ratio of momentum transfer and the geometry, the drag coefficient for a specific satellite shape can be computed. Tentative results indicate that the drag coefficient for monatomic oxygen on an Echo I satellite material is similar to that obtained for nitrogen. *Supported by NASA Langley under Contract NAS 1-2538.

THEORETICAL INVESTIGATION OF REACTIVE FLUID FLOW IN A HYBRID ROCKET SYSTEM. *W.S.Y. Hung**, *C.S. Chen**, *K.R. Hall**, *J.L. Gainer**, and *J.K. Haviland*, School of Engineering and Applied Science, Univ. of Va., Charlottesville, Va. 22901.

A theoretical study of a hybrid rocket system consisting of solid fuel and liquid oxidizer undergoing heterogeneous combustion is presented. In solving this problem initially, a mathematical model has been formulated based on certain simplifying assumptions. The continuity, species continuity, momentum and energy equations for the gas phase have been derived for transient, two-dimensional, turbulent flow of an N -component gas mixture with chemical reactions. The governing equation in the solid phase is the familiar transient, two-dimensional, heat conduction equation with no heat source or sink. Heat and mass transfer coupling between the solid and gas phases are assumed in the derivation of boundary equations at the interface. With the appropriate initial and boundary conditions, these second order, nonlinear, coupled, partial differential equations can be solved numerically by either the Lax-Wendroff or the Crank-Nicolson implicit finite-difference scheme of second order accuracy. The preliminary results indicate that the solution of this complex reactive flow system involving heterogeneous combustion are encouraging. (Sponsored by NASA, grant number NGR 47-005-085)

PROBLEMS ASSOCIATED WITH THE USE OF FERROMAGNETIC MATERIALS AS THE SUPPORT ELEMENT IN THE UNIV. OF VA. COLD BALANCE. J.R. Jancaitis*. Dept. of Aerospace Engineering and Engineering Physics, Univ. of Va., Charlottesville, Va. 22901

An increased control force capability for the Univ. of Va. Cold Balance System is desired. The use of a ferromagnetic material increases the force capabilities considerably but introduces the problem of rotational hysteresis. A model for the rotational hysteresis torque in two-dimensions is presented. Also, numerical and analytic solutions applicable to axis-symmetric bodies with four degrees of freedom experiencing aerodynamic and "coulomb" damping are included. A comparison is made between the magnitudes of the aerodynamic and rotational hysteresis motion.

(Sponsored by NASA Grant NGR 47-005-112)

UNDERDETERMINED DIFFERENTIAL CORRECTION PROCESSES AND THEIR APPLICATION IN DETERMINATION OF SPACE VEHICLE CONTROL VARIABLES. John L. Junkins*. Dept. of Aerospace Engineering and Engineering Physics, University of Va., Charlottesville, Va. 22901.

A survey of classical and recently developed numerical techniques for solving underdetermined boundary value problems is given. Three parametric differential correction processes, which have been recently developed by the author are discussed from theoretical and application-oriented viewpoints. Several examples which illustrate the basic features and relative computational merits of the various methods are discussed. Of particular significance is a second-order process which is demonstrated to be a computationally feasible means for efficiently solving constrained trajectory optimization problems. (This investigation was conducted under the sponsorship of a McDonnell Douglas Astronautics Company Study: Rapid Targeting—Hunting and Optimization Techniques, Account No. 9703,7506)

DRAG MEASUREMENTS IN HYPERSONIC, LOW DENSITY FLOWS. A.G. Keel, Jr.* and R.D. Passmore*, Dept. of Aerospace Engineering and Engineering Physics, Univ. of Virginia, Charlottesville, Va. 22901

A magnetic suspension system is used to measure the drag on cones in transition flows generated by free jet expansion. Drag measurements, made in the range from Mach 7 to Mach 12, correspond to those at altitudes of 25 to 100 miles above the earth. Given is a description of the equipment, the calibrating technique, and the experimental procedure used to obtain the data. Experimental uncertainty has been reduced by an order of magnitude with respect to previous work typical of this flow regime. (Sponsored by AFOSR-69-1798.)

THE OPTICAL MECHANICAL SCANNER AS AN IMAGING SYSTEM FOR PLANETARY LANDERS. W. L. Kelly, IV, NASA, Langley Research Center, Langley Station, Hampton, Va. 23365

One of the most important objectives of a planetary lander is to obtain spatial and radiometric characterization of the surrounding terrain to define its textual and structural properties. In the past, NASA has relied on two different types of imaging systems for lunar and planetary exploration: systems using either the vidicon tube or silver halide film as the sensor. A new type of imaging system has recently been selected for the Viking lander mission to Mars in 1975, called the optical-mechanical scanner or facsimile camera.

The optical-mechanical scanner consists basically of a radiometer and a scanning mechanism. Some of its advantages are low weight and power requirements, small size, and the capability to obtain well-calibrated multispectral data over a wide spectral region. Performance tradeoffs between signal to noise ratio, angular scanning resolution, depth of focus, and bandwidth have been analyzed for the Martian environment, and major design tradeoffs between mechanical versus electronic complexity have been studied for a planetary lander configuration.

DESIGN OF AN OPTICAL DATA ACQUISITION SYSTEM. M. Lapins*. Dept. of Aerospace Engineering and Engineering Physics, Univ. of Va., Charlottesville, Va. 22901

An optical data acquisition system for the Univ. of Va. cryogenically cooled electro-magnetic balance supersonic wind tunnel facility is described. The paper includes an explanation of the physical and optical constraints on the size of the system, image transmission, lighting, and data acquisition, as well as a discussion of the design of the distal end of the fiber-optics remote viewing instrument.

(Sponsored by NASA Grant NGR 47-005-110)

HIGHER ENERGY MOLECULAR BEAMS FOR STUDIES OF GAS-SURFACE INTERACTIONS. E.W. McClurkin, Jr.* and S.S. Fisher, Dept. of Aerospace Engr. and Engr. Physics, U.Va., Charlottesville, Va. 22901.

A heated convergent nozzle, through which are expanded mixtures of a light and a heavy gas into an evacuated chamber, has been developed as a source of higher energy molecular beams. When the concentration of the heavy gas is low, the mixture expands to essentially the adiabatic limiting speed of the lighter gas. Since the adiabatic limiting speed of a gas is inversely proportional to the square root of its molecular weight, the net effect is to accelerate the heavy gas to a speed higher than its own adiabatic limiting speed by the square-root of the ratio of the light-gas to the heavy-gas molecular-weight. At a point out in the expansion where the gas is sufficiently rarefied, a molecular beam is skimmed off for use as an experimental tool. Fortunately, the kinetics of the gas expansion are such as to enrich the concentration of the heavier gas in the beam itself. Mixtures of argon and helium heated up to 2000°K have been tested. Argon energies up to about 4 eV/atom are obtained. The scattering of these beams from heated tungsten targets has been investigated. (Research under NASA Grant NGR 47-005-046.)

FRACTURE MECHANICS FOR HOLLOW TEST SPECIMENS OF DIFFERENT MATERIALS. R.P. McNitt, S. Sawyer. Dept. of Eng. Mech., V.P.I., Blacksburg, Va. 24061.

Fracture mechanics is a means of predicting brittle fracture under various load-crack length (flaws) combinations. Elastic mathematical analyses lead to a term called the fracture toughness which characterizes the stress fields, for any configuration or loading, near the tip of the crack (flaw). It is postulated that cracks will propagate when a critical value of the fracture toughness (K_{Ic}) where σ is stress, $a =$ crack length is obtained. The plane strain value K_{Ic} is presumed to be a material parameter which must be experimentally determined. A possible specimen configuration to obtain K_{Ic} is the notched round specimen as it is believed that for ~~the~~ geometry plane strain conditions are easily achieved. In order to minimize testing loads the possibility of utilizing notched round hollow specimens as suggested by D.O. Harris was investigated. The experimental results using high strength 4340 steel and 7075-T651 aluminum are presented. The specimen geometry was altered by using various interior hole sizes and notch root radii. The apparent K_{Ic} thus obtained are summarized in graphical form. It appears that apparent K_{Ic} are independent of notch root radius for the large internal hole size. However large values of σ_{net}/σ yield may negate the significance of the K_{Ic} 's thus obtained. (Aided by the Dept. of Def. Project THEMIS, Contract No. DAA F07-69-C-044 with Watervliet Arsenal.)

STUDY OF NONLINEAR AERODYNAMICS IN THE U.VA. WIND TUNNEL ELECTROMAGNETIC BALANCE SYSTEM. B.S. Raghunath*. Dept. of Aerospace Engineering and Engineering Physics, University of Va., Charlottesville, Va. 22901.

The paper deals with the evaluation of nonlinear aerodynamic derivatives of missile type bodies. The use of inertial asymmetry and variable roll rate is considered for the determination of frequency dependent nonlinear damping derivative of axisymmetric bodies. (Sponsored by NASA Grant NGR 47-005-112)

ADSORPTION OF SEVERAL GASES ON 304 STAINLESS STEEL AT VERY LOW PRESSURES. M. Troy* and J. P. Wightman, Dept. of Chemistry, Va. Polytechnic Inst., Blacksburg, Va. 24061

Physorption isotherms have been obtained for argon, krypton, methane and nitrogen on 304 stainless steel in the temperature range 77°K to 90°K and in the pressure range 10^{-3} to 10^{-4} Torr. A static technique was used to obtain the isotherms whereby the pressure change of the gas in a constant volume system was measured on surrounding a stainless steel nipple with different cryogenic baths. The Dubinin-Radushkevich equation provided a good correlation of the data and extrapolated values for monolayer coverage indicated a roughness factor near unity for stainless steel. The isosteric heat of adsorption of the gases on stainless steel varied between 5.1 and 2.1 kcal/mole in the range of surface coverages from 0.0005 to 0.09. (Work supported under NASA Grant NGR 47-004-016.)

PROSPECTS FOR THE UNIVERSITY OF VIRGINIA COLD MAGNETIC BALANCE WIND TUNNEL SYSTEM. H.M. Parker. Dept. of Aerospace Engineering and Engineering Physics, Univ. of Va., Charlottesville, Va. 22901.

The U.Va. cold magnetic balance wind tunnel system is expected to demonstrate the feasibility of a unique approach to the experimental study of the dynamic stability of aero-dynamic configurations. Recent theoretical developments indicate that the potential of the method is even greater than had been originally expected. These developments and the currently foreseen prospects for applications will be discussed. (Sponsored by NASA Grant NGR 47-005-112)

THERMODYNAMIC ANALYSIS OF A SUPERCRITICAL MERCURY POWER CYCLE. A. S. Roberts, Jr., School of Engineering, Old Dominion University, Norfolk, Virginia 23508.

A heat engine is considered which employs supercritical mercury as the working fluid and a magnetohydrodynamic (MHD) generator for thermal to electrical energy conversion. The main thrust of the paper is power cycle thermodynamics, where constraints are imposed by utilizing an MHD generator operating between supercritical, electrically conducting states of the working fluid; and, pump work is accomplished with liquid mercury. The temperature range is approximately 300 to 2200°K and the system pressure is > 1500 atm. Equilibrium and transport properties are carefully considered since these are known to vary radically in the vicinity of the critical point, which is found near the supercritical states of interest. A maximum gross plant efficiency is 20% with a regenerator effectiveness of 90% and greater, a cycle pressure ratio of two, and with highly efficient pump and generator. Certain specified cycle irreversibilities and others such as heat losses and heat exchanger pressure drops, which are not accounted for explicitly, reduce the gross plant efficiency to a few per cent. Experimental efforts aimed at practical application of the power cycle are discouraged by the marginal thermodynamic performance predicted by this study, unless such applications are insensitive to gross cycle efficiency. (Work supported by AB Atomenergi, Stockholm, Sweden.)

HYPersonic PERFORMANCE, STABILITY AND CONTROL OF MANNED SPACE SHUTTLE CANDIDATES. W. C. Woods,* James P. Arrington,* and David R. Stone.* NASA Langley Research Center, Hampton Virginia 23365

The results of analytical and experimental studies to determine the hypersonic performance stability and control characteristics of vehicles representative of three proposed space shuttle designs -- fixed straight wing, fixed delta wing, and lifting body -- are presented. In addition, summary results of flow visualization studies utilizing the electron beam technique are presented in the form of a 10-minute color motion picture, and, in several instances, anomalies in the experimental measurements are related to flow interference patterns illustrated by the movie.

In general, the results being presented indicate these configurations are capable of achieving their design performance; however, both the force and moment data and the flow visualization results indicate the existence of flow interference problem areas which require more detailed study. Performance predictions, particularly at angles of attack near C_L max are quite sound, but trim and stability predictions are shown to be meaningless.

ON THE AEROELASTIC DIVERGENCE BEHAVIOR OF UNGUIDED, SLENDER LAUNCH VEHICLES. C. P. Young, Jr.*. Flight dynamics Section, NASA-Langley Research Center, Hampton, Va. 23365

The paper explores the major aeroelastic problem in unguided vehicles which is the phenomenon of aeroelastic divergence. The divergence problem is characterized as the loss of stability as a result of aeroelastic bending.

The character of the aeroelastic destabilization problem is reviewed and some results of flight experiences are discussed. The mathematical character of the steady-state problem is revealed and several analytical methods are compared. Some aspects of the applied analysis are discussed, any typical input data for an aeroelastic analysis are illustrated. Data from the analysis of two classical aeroelastic divergence failures are presented, which correlate theoretical predictions with actual flight results. Variations in the calculated aeroelastic stability measure versus slenderness ratio for a large number of vehicles are presented for evaluating the vehicle slenderness ratio as a gauge on aeroelastic stability. Also, the stability criteria used for vehicle flight acceptance are presented which assure stability between the extremes of flexibility and rigidity. Finally, remedial measures for alleviating aeroelastic instability are discussed.

AN ALTERNATE APPROACH TO THE GRAND-TOUR MISSION. J. W. Young*, M. E. Hannah*. NASA, Langley Research Center, Hampton, Virginia 23365.

A technique for extending the available launch window for 4-planet, Grand-Tour missions to Jupiter, Saturn, Uranus, and Neptune has been investigated. The launch window for this type mission has previously been considered to exist only during the 1976-1980 period with a repeat cycle of about 170 years.

Results are presented for a 4-planet, Grand-Tour mission with a launch period between 1990-1994. Comparisons with the standard 1976-1980 mission are given. Missions are contrasted with respect to total trip time, launch energy requirements, and planetary flyby conditions.

Section of Statistics

Forty-eighth Annual Meeting of The Virginia Academy of Science
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DOUBLE-STAGE SHRINKAGE ESTIMATORS. H. A. Al-Bayati and J. C. Arnold, Smith Kline and French Laboratories, Philadelphia, Pa. and VPI, Blacksburg, Va. 24061

A double-stage shrunken estimator (DSSE) for any parameter θ is considered for lowering the mean squared error in a region of interest, $R = [\theta_0 - c, \theta_0 + c]$, where $c > 0$ and θ_0 is an initial estimate of θ . The proposed DSSE is as follows: a sample of size n_1 is obtained and the classical estimator θ_1 is computed. If $\theta_1 \in R$ then a shrinkage estimator $k(\theta_1 - \theta_0) + \theta_0$ is used as the final estimator, where $k < 1$ is a constant. If $\theta_1 \notin R$, a second sample of size n_2 is obtained and the estimator is computed using $\theta_1 + n_2$ observations.

The usage of the DSSE is illustrated for the cases of estimating means, variances, means and variances, and linear regression models. All of these illustrations show that a considerable decrease in mean squared error is achieved in the region R .

It is also shown that shrinking the estimator in R uniformly improves the double-stage preliminary test estimators. At the same time there is a considerable saving in the number of observations needed to estimate θ .

A MARKOVIAN SAMPLING POLICY APPLIED TO WATER QUALITY MONITORING OF STREAMS. J. C. Arnold, Va. Polytechnic Institute, Blacksburg, Va. 24061

A sampling procedure for monitoring the outgoing quality of a process is considered. Though the sampling procedure is applicable to other sampling inspection problems, our specific concern is the application to quality control sampling of dissolved oxygen in streams. The procedure uses a variable sampling ratio, sampling less frequently when the process is in control. The problem is formulated as a simple Markov process.

For each of the various sampling plans considered, the expected sample size required and the probabilities for detecting pollution within t time units are given. Examples are included illustrating the use of such a sampling procedure by an agency in the planning, evaluation, and economics of various sampling plans.

A MONTE CARLO CASE STUDY OF RANDOM INPUTS IN THE STOCHASTIC MODEL FOR POLLUTION IN ESTUARIES.
Sandra Bartley and Richard G. Krutchkoff. Dept. of Statistics, Va. Polytechnic Inst., Blacksburg, Virginia 24061

Using Krutchkoff and Custer's stochastic model for pollution in estuaries, a Stochastic Simulation study of random inputs of pollution particles in estuaries was made. This study investigated four types of input in each of twelve estuarial situations and examined the resulting average distributions of both the biochemical oxygen demand and the oxygen deficit. For two types of input, the number of input particles ranged from zero to ten and was chosen randomly from a binomial distribution and a uniform distribution; another type of entry used an input of zero or ten particles, each with a probability of .5. These three situations were compared with a constant input of five particles, which was the mean number of input particles for each of the three probability-input cases. Graphs were plotted using all four types of input for each estuarial situation. On the basis of these graphs, the study indicates that the average distributions of both pollution particles and oxygen deficit particles which result from using random inputs do not differ significantly from each other and from the average distributions using the mean input.

BAYESIAN ESTIMATION OF RELIABILITY IN THE GAMMA LIFE TESTING MODEL. G. C. Canavos*, NASA Langley Research Center, and C. P. Tsokos*, Va. Polytechnic Institute.

The aim of this paper is to obtain Bayesian estimates of the reliability function based on a gamma failure distribution with a random scale parameter for the uniform, exponential, and inverted gamma prior probability distributions. Bhattacharya's results for the one parameter exponential life testing model are reduced to a special case of the present results.

Utilizing a Monte Carlo simulation of lifetimes distributed according to the gamma failure model, a comparison between the Bayesian estimates of reliability and the minimum variance unbiased estimates (m.v.u.e.) obtained by Tate and Basu using the Rao-Blackwell and Lehmann-Scheffé theorems indicated conclusively the superiority for the Bayesian estimates to the m.v.u.e.

TIME SERIES ANALYSIS OF WATER POLLUTION DATA. F. C. Fuller, Jr.* and C. P. Tsokos*. Dept. of Statistics, Va. Polytechnic Inst., Blacksburg, Va. 24061

It is becoming ever more apparent that there is a great need for more effective management of water quality (i.e., control of water pollution). This has already resulted in the development of more sophisticated measuring devices and techniques which can measure continuously several variables of interest. It is desirable to obtain the maximum information from these measurements: to attain a more fundamental understanding of the underlying physical phenomena and to arrive at a model which can be used for forecasting purposes. Time series analysis techniques are readily applicable to this type of data and are so applied in this paper to analyze water pollution measurements in a meaningful way, achieving maximum information from the data.

THE GENERALIZED INBREEDING COEFFICIENT AND THE GENERALIZED HETEROZYGOSEITY INDEX IN A RECURRENT SELECTION PROGRAM. R. L. Cain and K. Hinkelmann. Dept. of Statistics, VPI, Blacksburg, Va. 24061

Methods of calculating the inbreeding coefficient in a finite population undergoing recurrent selection are investigated. Since in a population under selection the inbreeding coefficient does not provide the experimenter with a measure of expected degree of variability, an index of total heterozygosity is required.

Formulae necessary to calculate both the inbreeding coefficients and the heterozygosity indexes are derived for the cases: one-locus, two alleles, random selection; k independent loci, random selection; one-locus, two alleles, effective directional selection; and k linked loci with effective directional selection. These formulae involve defining a generalized inbreeding coefficient and a generalized index of homozygosity in terms of vectors whose components reflect the various possible patterns of genes identical by descent at a given stage of the recurrent selection breeding program.

The progress of the panmictic index and/or the index of total heterozygosity is observed in various computer-simulated populations.

STATISTICS AND SECTION 18.1-54 OF THE VIRGINIA CODE.

Walter H. Carter, Jr., Roger E. Flora, Raymond H. Myers, Dept. of Biometry, Va. Commonwealth Univ., Richmond, Va. 23219, J. Van Bowen, Dept. of Mathematics, Univ. of Richmond, Richmond, Virginia.

Whenever a trial is conducted there is a chance of convicting an innocent person or freeing a guilty person. Since an accused is innocent until proven guilty, it follows that a null hypothesis of innocence accompanies every defendant until there is sufficient evidence to conclude that he is guilty beyond a reasonable doubt. In Virginia, an individual is presumed guilty of driving under the influence of alcohol if the results of two independent blood alcohol analyses indicate that the accused's blood alcohol content was at least 0.15% by weight. Hence, the null hypothesis here is that the accused's blood contained less than 0.15% alcohol by weight. In this paper it is assumed that the two analyses were performed with equal precision and that the results come from populations with equal means. These two assumptions, in addition to the independence of the observations, allow one to use a t-test with one degree of freedom to test the null hypothesis. This was done for nine defendants and the results are presented.

WHAT IS THE USE OF A DISTRIBUTION? I. J. Good, Dept. of Statistics, Virginia Polytechnic Institute, Blacksburg, Va.

Suppose that a formula, such as a quadratic, is assumed for the utility v of asserting that a random number or a random vector has one value when it really has some other value. Of course v is a function of two variables. Formulas are proposed for the utility U of the assertion that the distribution of the random vector is G when it is really F , where U is a generalized expectation of v . The formulas satisfy various axioms.

- (i) if a constant is added to v then the same constant is added to U ;
- (ii) U is additive for a pair of mutually irrelevant vectors;
- (iii) U is unchanged when a non-singular transformation is applied to the random vector.

One of the formulas satisfies a fourth axiom: that it is optimal to assert the correct distribution. When $G = F$, this formula is an "Invarianzified" form of negative entropy. The formulas could be used both in the design of experiments and in the summarizations of their results.

The principle of maximum entropy for the specification of distributions is a special case of a principle of maximum invarianzified entropy, and this in its turn is seen to be a special case of a "principle of least utility". This is a minimax procedure.

The Jeffreys invariance theory is obtained by taking v as an expected weight of evidence. Thus the present theory brings several methodological strands together.

CANONICAL EXPANSION OF THE BIVARIATE NEGATIVE BINOMIAL DISTRIBUTION. S. W. Hinkley* and C. P. Tsokos*, Dept. of Statistics, Va. Polytechnic Institute, Blacksburg, Va. 24061

In this paper some of the properties of the bivariate negative binomial distribution are set forth and results relating the parameters of the bivariate distribution to those of the marginal distributions are given. By consideration of the orthogonal polynomial expansion of the marginal distribution functions a canonical expansion is obtained for the bivariate distribution function. This expansion is then utilized to obtain an estimator for ρ , the correlation coefficient.

EMPIRICAL BAYES ESTIMATORS FOR TIME SERIES PARAMETERS. Robert Launer and Richard G. Krutchkoff. Dept. of Statistics, Va. Polytechnic Inst., Blacksburg, Va. 24061

The pseudo-maximum likelihood estimates of the parameters in the autocorrelated time series model have been extensively studied and are asymptotically distributed as multivariate normal random variables. The properties of the M.L.E.'s of the parameters in the time series regression model are not so well known, since the normal equations are non-linear, and require an iterative solution procedure.

In this paper, it is assumed that the time series parameters are independent realizations of a random variable with unknown distribution functions. It is then shown how the M.S.E. of the classical estimates of the time series parameters can be reduced by utilizing the "current" estimate in conjunction with the estimates of several previously observed time series.

OPTIMUM CHOICE OF CLASSES IN THE CHI-SQUARE TEST. R.E. Leiter, Jr.*, M.A. Hamdan*. Dept of Statistics, Va. Polytechnic Inst., Blacksburg, Va. 24061

This paper considers the problem of optimum choice of classes in applying the chi-square test for the mean of a normal population. The chi-square criterion is expressed in terms of a set of simple orthonormal functions and hence the parameter of non-centrality of chi-square is expressed in terms of the class boundaries and the mean of the normal population. We then choose the class boundaries which maximize the parameter of non-centrality. Upon comparing our formula for the parameter of noncentrality with the limiting formula as the number of classes is indefinitely increased, it is found that no significant increase can be achieved by taking a number of classes greater than 20; and even 10 classes are sufficient. The present results are compared with those of Mann and Wald [Ann. Math. Stat. (1942)] and Hamdan [JASA (1963)].

MAXIMUM LIKELIHOOD ESTIMATION OF ρ IN CONTINGENCY TABLES DERIVED FROM THE BIVARIATE NORMAL DISTRIBUTION. E.O. Martinson*, M.A. Hamdan*. Dept of Statistics, Va. Polytechnic Inst., Blacksburg, Va. 24061

Tallis [Biometrics (1962)] considered the problem of maximum likelihood estimation of ρ and the points of polychotomy in contingency tables derived from the bivariate normal distribution. The solution of Tallis's equations is rather lengthy and complicated even for the particular cases of 2x2 and 3x3 tables which Tallis considered. The present paper gives a method for obtaining a maximum likelihood estimate $\hat{\rho}$ by a single equation, based on estimating first the points of polychotomy by fitting a normal distribution to each marginal. For any rxc table a single program produces $\hat{\rho}$ and its asymptotic variance. By illustrative examples, we compare our method with Tallis's method, Pearson's ϕ^2 method and Lancaster & Hamdan's polychoric series method.

EMPIRICAL BAYES ESTIMATES OF QUEUEING PARAMETERS. Donald Miller and Richard G. Krutchkoff. Dept. of Statistics, Va. Polytechnic Inst., Blacksburg, Virginia 24061

It is frequently of interest in a queueing situation to estimate the parameters of the system. These include the arrival and service parameters, the traffic intensity, and several functions of these parameters. In particular, systems are considered which have either exponential or Erlang inter-arrival time and/or service time distributions.

There are several schemes by which a queueing system may be observed. One can observe for a fixed period of time, for a fixed busy period, or for a fixed number of arrivals, departures, or transitions. Empirical Bayes estimators of all the parameters are found for each scheme and for each combination of the aforementioned inter-arrival time and service time distributions.

As a by-product of the above work, a class F_1^k of families of conditional distributions is given which is particularly useful in estimating powers and inverse powers of parameters.

ON EASY CONFIDENCE INTERVALS IN ELEMENTARY STATISTICS. Peter Nemenyi. Dept. of Statistics, Virginia State Col. Petersburg, Va. 23803

This work is based on the belief that Elementary Statistics should begin with the most elementary methods, which are distribution-free. Given one sample, we begin with the sample median \bar{x} and the confidence interval $(x_{(c)}, x^{(c)})$ for an unknown population median, where $x^{(c)}$ means the c-th highest sample value. Given two samples we suggest using $(y_{(b)} - \bar{x}, y^{(b)} - \bar{x})$ as confidence interval for

$\mu_2 - \mu_1$ and the associated Mathisen test. The efficiency of the method approaches $2/\pi = .64$ same as that of Mood's interval.

THE ORIGIN AND APPLICATIONS OF STOCHASTIC INTEGRAL EQUATIONS. W.J. Padgett* and C.P. Tsokos*, Department of Statistics, Virginia Polytechnic Institute, Blacksburg, Virginia 24061.

Random or stochastic equations appear frequently in the mathematical description of phenomena in the biological, engineering, and physical sciences. The manner in which these equations arise is elucidated and several important applications of stochastic integral equations of the Volterra type in the engineering and biological sciences are presented in order to acquaint the reader with the importance of stochastic equations and how they are used in physical situations. Included in these applications are problems in control theory, statistical turbulence, and telephone traffic theory. Two biological problems, one concerning a mathematical model for chemotherapy and the other concerning population growth, which have been treated previously as deterministic integral equations are presented in a more realistic stochastic framework.

FACILITY LOCATION AND DESIGN: A REVIEW. J. A. White*, Dept. of Industrial Eng., Va. Polytechnic Inst., Blacksburg, Va. 24061

In recent years there has developed an interest among several academic disciplines concerning the problem of optimally locating and designing facilities. Due to this interest a substantial literature has been produced on the subject. The objectives of this paper is to review the contribution of operations research in the analysis of facility location and design problems. The current state of research is examined and areas for further study are cited.

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2. Chappell, J. B., Cohn, M., and Greville, G. D., in B. Chance (Editor), *Energy linked functions of mitochondria*, Academic Press, Inc., New York, 1963, p. 219.
3. Riley, G. A., and Haynes, R. C., Jr., *J. biol. Chem.*, **238**, 1563 (1963).

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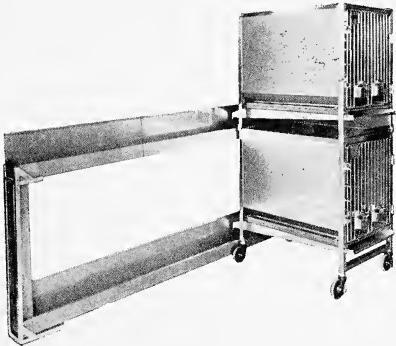
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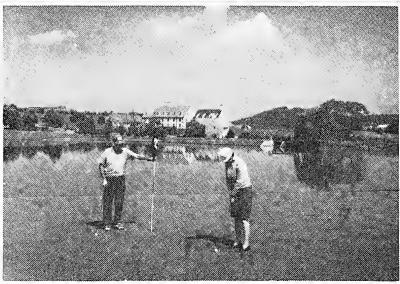
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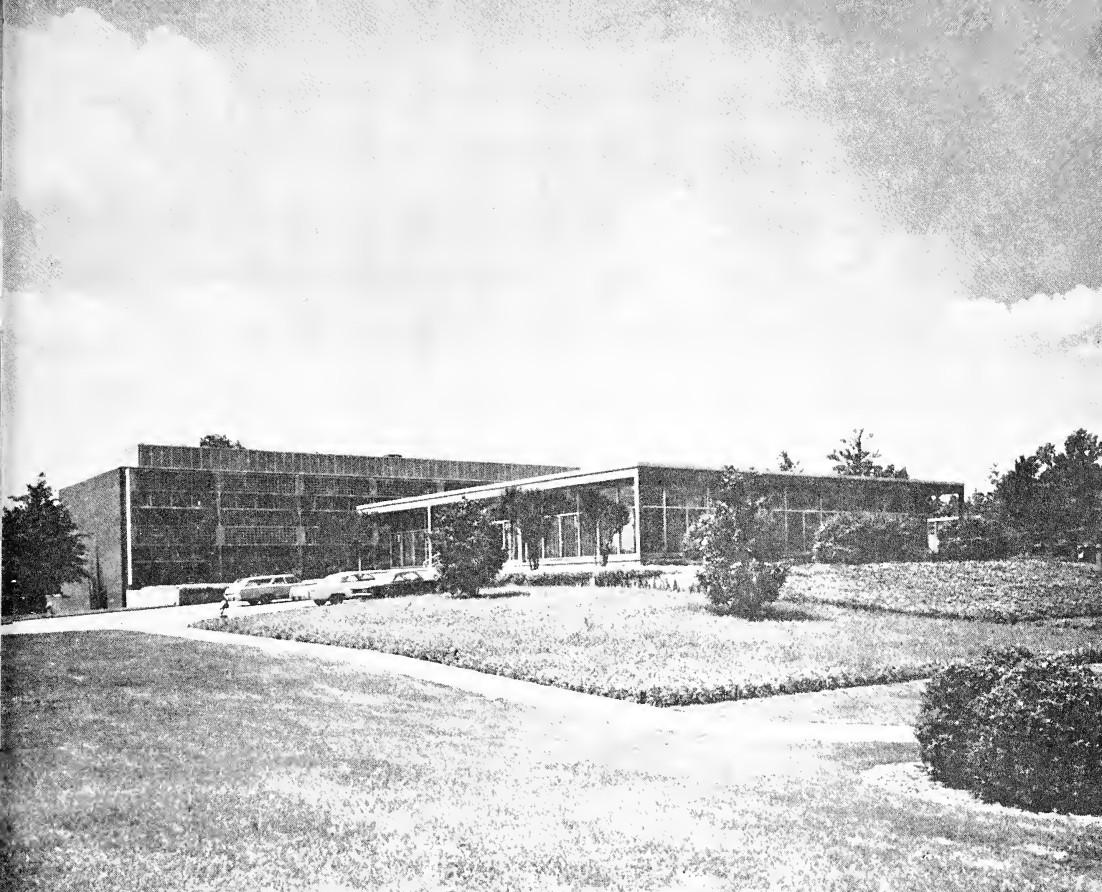
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Giant Discoveries of Future Science*

"When a scientist states that something is possible, he is almost certainly right; when he states that something is impossible, he is very probably wrong" (1). This quotation from Arthur C. Clarke's *Profiles of the Future* captures the essence of my talk today.

In industry, government, and increasingly in the scientific community itself, there is an increasing interest in identifying the benefits of science. At the same time, there is a conservative reluctance on the part of scientists to predict, or even to discuss, potential breakthroughs; and yet, it is in these areas that the benefits have been most staggering in the past, and undoubtedly will be most staggering in the future.

First, I have to point out before anyone does —this title is an obvious affront to modesty; however, there is a basis for believing that the *subjects* of science for the future are a logical part of science. After all, the essence of science is trying to discover the laws that enable one to predict how an experiment will behave. What could be more appropriate than trying to predict the subjects of these laws themselves?

The scope of the talk addresses *science*. *Science* is defined (for this evening anyway) as that scope of activity which addresses itself to the *why*; which talks about the very, very small to the very, very large; which has its value in its ability to reliably predict behavior, and which aims at a fundamental understanding. This is different from *engineering*, which by contrast, deals with the *how*; generally involves man-sized kinds of things; and where the fundamental understanding is used only as a means to an end (a step which you should do without if it is cheaper). That's engineering. Future giant engineering discoveries, such as a controlled thermonuclear fusion reactor which would run on sea water, would be very important; but they are not the subject of my talk tonight, assuming such a reactor would run on the principles of science we now understand. Furthermore, the *future* I am talking about is not a future that when we are all gone nobody cares about, it's a time period that is of importance to this audience; so I have defined the future as 1990, or twenty years from now. Later I will make predictions of the probabilities of certain

giant discoveries occurring by 1990; most of us will still care, I think.

The ability to actually predict the fundamental sciences is, of course, of obvious importance. The pre-atomic bomb planning, I am sure, had many, many man-hours of wasted effort; and the pre-Sputnik planning the same thing. For instance, I recently found out that after the atomic bomb had been dropped at Hiroshima, Japanese scientists issued a statement that we had developed a new weapon, a dust bomb (you know, like the kind of explosion you get in a flour factory), because their scientists had concluded that it was impossible to release nuclear energy (2). Furthermore, I am always reminded of the now classic quotation (that I am sure he wishes he had never made) of the British Astronomer Royal two months before Sputnik, when he said, "Space travel is utter bilge."

Having now dissected my title, I will mention where we are in this talk. We are now somewhere between the Introduction and the Definitions. We'll talk about the Discoveries of the Past, Discoveries of the Future, some Paradigms in the Making, and as I am a manager, what Action has to be taken.

Paradigm is a word which I am sure caught your attention immediately. This is a definition taken from Thomas Kuhn's delightful book *The Structure of Scientific Revolutions* (3). Paradigms are "universally recognized scientific achievements that for a time provide model problems and solutions to a community of practitioners." For example, when Ptolemy had this idea that the sun went around the earth, that was the paradigm of the day; when Copernicus came along and said, "that's not right, the earth goes around the sun," it was a new paradigm. When one paradigm replaces another, you have a *scientific revolution*. That's what the book is all about. And that is what my talk is about too.

Another thing that consistently characterizes paradigms is the way that people talk about them; that is, when the new paradigm community is trying to talk to the old paradigm community. "Incomplete logical contact consistently characterizes paradigm debates" (4). In other words, a lot of *emotion* exchanges between these two groups; this leads me to the last point I want to make in the introduction. Our society has developed a pretty good system for dealing with subjects that have high emotional content, and this is our system of courts of law. There are two principles, by and large, that are closely

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controlled in our courts of law—the principle of “guilt by association” and the principle of “proof by analogy.” An example of proof by analogy is one often used by the crackpot community—“They laughed at Fulton, they’re laughing at me, hence I’ve got it.” I think you will see as we get on later why I mention these two aspects of “guilt by association” and proof by analogy.” They are things that we all, either consciously or unconsciously, engage in constantly.

Let’s move, then, right into the discoveries of the past; this is my list of the 12 greatest discoveries of the past (Table I). I am sure that a better list can

TABLE I
Giant Discoveries of the Past

Discovery	Discoverer	Date	Age
Earth goes around sun	Copernicus	1543	40
Understanding of astronomy, gravity	Galileo	1600	34
Principles of motion, gravitation, calculus	Newton	1665	23
The nature of electricity	Franklin	1746	40
Burning is uniting with oxygen	Lavoisier	1774	31
Earth evolved by gradual processes	Lyell	1830	33
Evidence for natural selection controlling evolution	Darwin	1858	49
Field equations for light	Maxwell	1864	33
Transmutation of elements	Curie	1896	34
Quantum theory	Planck	1901	43
Special theory of relativity, $E = mc^2$	Einstein	1905	26
Mathematical foundations for quantum theory	Schroedinger	1926	39

be made. For example, the criticisms that I have already received about the list are that there are not enough discoveries before 1543 (like, “How about the number system?”), and also, there are not enough discoveries after 1926 (like, “How about DNA and some other really great things we have learned?”). Those are good criticisms.

The first discovery that I have shown is that of *Copernicus* where his paradigm, as I had mentioned, is that the earth goes around the sun. He published this in a private monograph at the age of 40, distributed it only to his friends; then, 30 years later (at the time of his death at the age of 70) it was distributed to the whole community (5).

Galileo took the main theme that *Copernicus* had advanced, and used an *experimental* device, the telescope, to really add a great deal of structure to our understanding of astronomy; in the process he also started to advance some of the laws of motion and gravity. He was followed by *Newton*, who quickly enlarged on the groundwork laid by *Galileo* with respect to the laws of motion and gravitational attraction; he added another wrinkle, namely the calculus. Since the mathematics was not in existence at the time, he had to create his own, so he added *ordinary* differential equations as part of the tools that could now be used to study these questions. A non-mathematical giant was *Franklin*. (Incidentally,

he is the only American on the list, and that is one of the reasons the list should be improved.) He didn’t think in terms of differential equations; he was a phenomenologist and the main contribution he made to science was to clearly state the nature of electricity; electricity consists of electrons with plus or minus charge. He explained the Leyden jar and many other things. *Lavoisier* basically replaced the previous paradigm, that of the phlogiston concept (air, earth, fire and water) and said that burning is simply uniting with oxygen. He put all of the elements in this context. He was 31 when he did that.

Unknown to me until I did a little background reading for this talk, prior to *Lyell*, most people thought that the earth had evolved by enormous cataclysms; and he had advanced the hypothesis that it was a gradual process. The evidence for a natural selection was collected by *Darwin*, who went around the world and took the time to do really a good, thorough job. In the process he also proposed that both man and apes originated from a common ancestor. *Maxwell* did a wonderful thing; he connected electric fields, magnetic fields, and electromagnetic fields all in one set of differential equations which we still use today, the Maxwell Equations. He enlarged on Newton’s beginnings of differential equations by using partial, vector, differential equations which were required for the problem he had.

Madame Curie started us on our way to the understanding of nuclear science with the beginnings of transmutation of the elements (and the confirmation of alchemy). *Max Planck* I have shown for the quantum theory. Actually, *Pauli*, *Heisenberg*, and others, even *Einstein*, contributed to that. After all, though, *Planck’s* constant is the one you have to use if you are going to do any quantum calculations, so I have shown his name after that; he was about the first. *Einstein*, in the space of one year, contributed three papers; the proof that light occurs in quanta, the $E = mc^2$ concept, and the special theory of relativity, all at the age of 26. And lastly, *Schroedinger* took the basis of quantum theory, wrote down the set of equations which would describe it mathematically and added another new wrinkle. He said not only are the equations partial vector differential equations, but they are also *statistical* in their very character, since they are describing a statistical phenomenon.

Some general observations about the discoveries and about the men; first, you will note that I have mentioned some of their ages. The average age is 36. What this suggests is that *eminence does not necessarily correlate with significance*. Since these men were not eminent at the time they made their discoveries, it would be fair to make that statement. The paradigm makers are often the rebels. *DeBroglie* said, “While prudence is the mother of security, it is on the audacious that fortune smiles.” They are driven not only by their interest in science, but also by other things in life. They are people just like anyone else. The general populace doesn’t often understand that, but I would like to read you a quotation from a letter that *Pauli* wrote to a friend in the

month before Heisenberg's paper on matrix mechanics pointed the way to a new quantum theory, "at the moment physics is again terribly confused, in any case it is too difficult for me and I wish I could have been a movie comedian or something of the sort and had never heard of physics" (6). Another aspect that I think emerges from the discoveries is that by and large the discoveries were made by *interdisciplinary* considerations. This is consistent with my definition of creativity. Creativity is taking what you learned in one context and applying it in a totally different one. These men generally did that sort of thing. For example, from an invention viewpoint, I have to note that it was not a couple of aeronautical engineers that invented the airplane; it was a couple of bicycle mechanics (7). Townes, in an article in *Science* a few years ago (8), discussed the elements of surprise in the development of the laser, and pointed out that if you had gone out of your way to design a better clock, find a better way to treat the eye for certain kinds of disease, get a more accurate measure of distance, find new photographic techniques, and get a new metal-cutting tool, that if you had given these problems to the specialists in the fields, they would have never come up with the laser.

Finally, I would stress the role of *imagination*. Fig. 1 shows one way of looking schematically at what may be going on; that there are many ideas represented by the clouds of imaginative intuition that float past. There is a main stream of disciplined activity, and disciplined competence, that goes on, and occasionally you will find one man who has the intuition, imagination and the competence to make

them meet and that is when you have a discovery (2). Imagination is actually often exemplified in science fiction, both in the past and today. You probably have heard of the story predicting the atomic bomb prior to its development in an article titled *Deadline* by Cleve Cartmill, published in March, 1944 (9). This was so realistic a description of the atomic bomb that he was grilled because of the Manhattan Project. We tend to laugh at Dick Tracy and Diet Smith's magnetic space coupe; every six weeks there is a little quotation, "The Nation That Controls Magnetism Will Control The Universe." Who knows, it could be right. Star Trek was a wonderful program, I think. I've seen very few incidents that I feel are totally impossible. Many scientists are actually contributors to science fiction; they often do it under pen names, but sometimes they don't. Fred Hoyle has written one called *The Black Cloud* (10). It is excellent. Imagination, therefore, tends to be the pacesetter, and that is what has governed my list for the giant discoveries of the future.

In Table II I have listed the 12 "big ones" before 1990, and probabilities by 1990 that I think they will occur. I shall explain what I mean by probabilities. To give you a feeling for what they mean, I'll take the first one and point out that it could mean three different things. First, the *discovery of extraterrestrial intelligent life* could mean that we find a signal from a distant planet, near a distant star, that has information in it which we then decode. The probability of this occurring I estimate at 0.9. There also is the probability that we would have a total society/society interaction with an extraterrestrial society. That I would also put at 0.9. The 0.99 refers to the

IMAGINATION/COMPETENCE

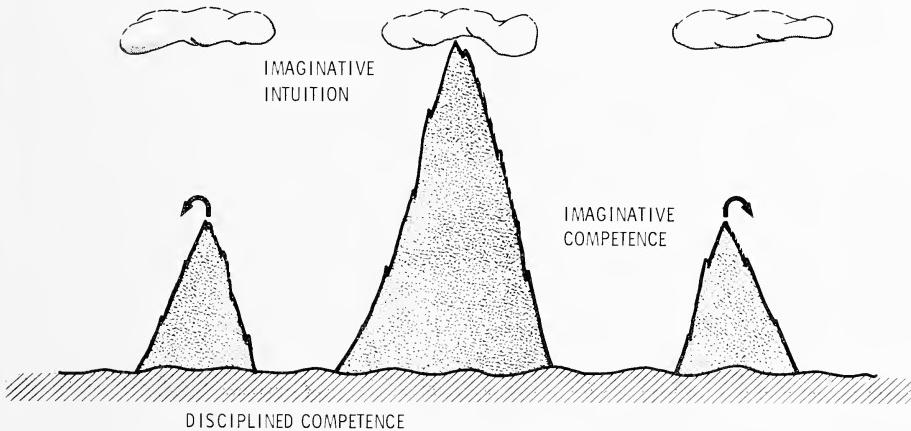


FIG. 1—Role of imagination.

TABLE II
Giant Discoveries of the Future

Discovery	Probability by 1990
Extraterrestrial intelligent life	.9 to .99
The origin of life	.9 to .95
The origin of man	.9 to .95
The basic mechanism of the solar cycle	.9 to .95
The confirmation and basis of ESP	.8 to .9
The processes of the brain and mind	.7 to .9
Cosmic and planetary evolution	.5 to .9
Unified physical theory	.7 to .8
Gravity amplification	.5 to .8
The nature and control of aging	.6 to .8
Teleportation principles	.01 to .1
Time travel principles	.001 to .1

observation of the earth by extraterrestrial craft not of earthly origin. This is more probable in my opinion than our discovering another society on their planet. The reason is that if there are many intelligent societies in the universe, some will no doubt be more advanced than ours. Some estimates of the number of such societies are considered in a scholarly but easy-to-read book by Shklovskii and Sagan, *Intelligent Life in the Universe* (11). These societies would therefore find it easy to come here if the interstellar propulsion problem can be solved. The spirit of this subject is best captured by Walt Kelly's Pogo cartoon in the same book. Porcupine is talking to Pogo, and says, "I been readin' about how maybe they is planets peopled by folks with advanced brains." Pogo says, "Um." Porcupine says, "On the other hand maybe we got the most brains, maybe *our* intellects is the universe's most advanced . . . Either way, it's a mighty soberin' thought."

The next discovery is the *origin of life*. What we are talking about here is whether or not life can originate most anywhere, on any planet, or whether it is really a sheer accident for this planet; as it originates, does it take its own statistical course, resulting in totally different life forms; or is there sort of a panspermia; or is all of the life throughout the universe basically similar? This kind of question I think we will find the answer to.

Going on down, I think we will find about the *origin of man*. Of course, if it turns out that any of this life (extraterrestrial) is *homo sapiens*, we may get help from the top of the list because "they" ought to know too. I have this next one on the list because it is one on the list that I have done some personal work on and it's a tough problem in science. (I'll come back to this one later.)

Confirmation and basis of ESP: I will define at this point what I mean here. I mean mind-to-mind communication, mind over matter, clairvoyance and precognition. I don't mean the total occult—the ghosts, apparitions, reincarnation and all that sort of thing. Let's say the "non-illegitimate" portion of ESP, I shall return to this subject also.

Not unrelated to that, perhaps, are the *processes of the brain and the mind*. Here you can imagine devices or inventions coming about, such as direct teaching by a computer to the mind, or "smart pills,"

which were invented by L. Frank Baum in the Wizard of Oz series (12), years ago, on paper. You take a pill and you know arithmetic—that sort of thing. Understanding of the processes I would put at quite a high probability. Our ability to invent devices like that is another question.

The *cosmologist and planetologist* are on the same line, even though they wouldn't agree. I feel that we would have a pretty good chance, at the 0.9 level, of really getting an excellent understanding by 1990 as to how our planet and the other planets evolved in the solar system, with good comprehension of the details of that process. But not so good a grasp on the whole of the universe, simply because we can't see to the edge now, and we may not be able to see by 1990, and if you can't see the whole of what you are trying to look at how are you going to be able to explain the whole of it?

Moving down to the *unified physical theory*: I am talking about something that would collect the current state of affairs in physics. Probably Pauli's description of being utterly confused is still applicable. The theory would collect all of our so-called fundamental particles together with gravitation, electric fields, magnetic fields, and nuclear fields and put them all under one roof. This discovery will be so giant that as soon as we make it, the inventions will emerge just like the coins in a jackpot at Las Vegas. You just *can't imagine* what will come from an understanding at that level. I feel optimistic that we have an 0.8 chance.

One possible aspect of this unified physical theory is *gravity amplification*. I have called it that instead of anti-gravity because, in principle, I think we are talking about not just changing it between plus or minus one, but going to 10 g's, 100 g's, 1000 g's, etc., without affecting the occupants in an adverse way. That, of course, is a tough one; you can see from the numbers so far that I have confidence.

Next, the *nature and control of aging*. What I mean is not just controlling some of the more important diseases we have and solving all of those like cancer, but basically making a 100-year old man perform as if he were 40 (and look like he is 40). Unfortunately, that probably affects only the people who will be *born* in 1990, rather than the audience.

You can see that even though I am optimistic to this point, I do have my moments of pessimism and I think *teleportation principles* are maybe a tough one. The way I got to 0.01 to 0.1 is as follows: the last couple of years I have been reading other parts of the literature in the occult just to see what I was missing. (A lot of it is worth missing.) However, it is my understanding that in certain séances, there are certain mediums that are alleged to be able to create a gem between clasped hands just out of nothing, and that I would describe as teleportation. Now, since nine out of ten mediums are frauds or maybe 99 out of 100, that means that one out of ten or one out of 100 is not.

Time travel principles. Even if we find out that ESP is genuine, and we understand it, and there is such a thing as precognition, it still gives me a

feeling that it is a very chancy thing. I don't want to go into a time tunnel any less reliable than the one that is already on TV. I think that reliability might be the problem, even though we might understand in principle how to do it.

I think that the paradigms, or the giant discoveries of the past, that I showed in Table I are all in jeopardy of being modified. For example, I think Maxwell's equations may have a few missing terms that nobody has missed because we have never used the conditions where they would have been missed. Cataclysms may have rocked the earth together with Lyell's steady changes; we may have originated from a common ancestor with the apes, but on another planet; hyperoptic space drives may work on the principle of the unified field theory, for which Einstein searched but never found. Some of the paradigms in the making are discussed in a charming little book by Ted Gordon, an acquaintance of mine, called *Ideas of Conflict* (13). He included discussions of the experiments on the effect of prayer on plant growth and the chemical transfer of knowledge.

I am now going to discuss three possible paradigms in the making. One of them relates to the sunspot cycle, one to unified physical theory, and one to ESP. One day I was visiting my father (a retired Professor of Aeronautical Engineering) at the University of Colorado, and asked him what was going on. He said, "Well, I think I've got a way to figure out the 11-year cycle of the sun." After

several hours he convinced me he might have something, and I suggested we put it on a computer. This is a brief summary of the current status (14). The position of the center mass of the solar system is shown in Fig. 2. This is where (if all the planets

SOLAR POSITION

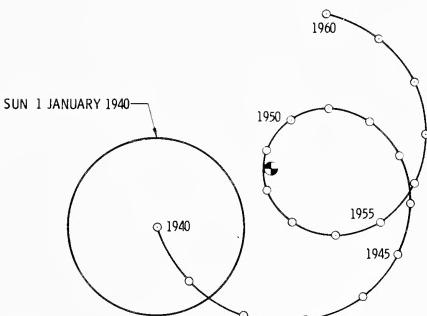


FIG. 2—Position of the center mass of the solar system.

were on a massless table) the table would balance. The sun sometimes lies outside of the balance sim-

SOLAR ACCELERATION (CYCLE 18)

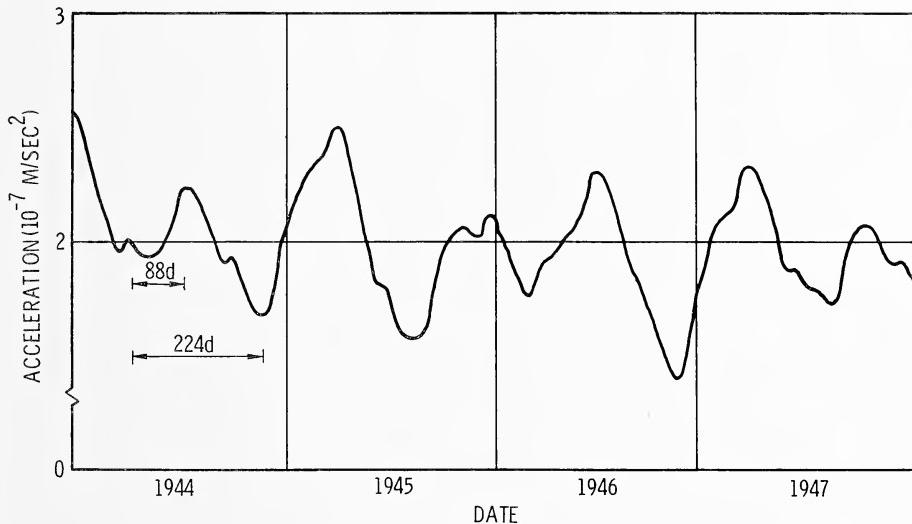


FIG. 3—Acceleration of solar system.

ply because Jupiter is about a thousandth the mass of the sun, but is about a thousand times as far away as its radius. The sun describes a position in inertial space that is really moving. This is the way it moves in space. If you will look at a couple of the higher derivatives of the position, namely the acceleration (Fig. 3) you will find that it is wiggly. The reason it is wiggly is because the little wiggles on the position curve, when differentiated a couple of times, become quite exaggerated, and you can start to see the 88-day period of Mercury and the 224-day period of Venus. If you take another derivative, (Fig. 4) (which is the jerk, a perfectly good term often used by the biologists), then compare that with the Wolf number (which was the measure of the number of sunspots we had in 1947), you get a comparison which is suggestive. It doesn't work for other years, and I haven't found a solution, but I am sure somebody will sometime. When it is found, we will then be able to say something like this: "The planets jerk the sun around and, in the process of this jerking, through a physics we don't thoroughly understand the details of, solar flares are caused and protons are emitted. These protons strike the upper atmosphere of the earth, causing rainfall, which affects tree ring growth. This is well documented in correlating with the 11-year cycle. Thus, rainfall affects the harvest, and that relates to the commodities market, which correlates with the stock market. So, the positions of the planets affect the Dow Jones averages." The basic premise of astrology is that the positions of the planets affect the affairs of men, and, if and when this concept is proved to be correct, it will turn out that the basic premise of astrology will have had some cause for truth. Astrology is a

field that has a very low signal-to-noise ratio—it's got a lot of chaff in the wheat; but sometimes a large number of weak signals are as good as one strong one. I am reminded, for instance, of the following case in point: I understand that in some societies it has long been regarded as appropriate treatment to put a spider web on an open cut. We have recently discovered that one of the important constituents in spider webs is penicillin (15). This example is like taking something that used to be magic, and making it science. In magic, you have a cause and an effect, and the reader is never permitted to examine what goes on between. *The examination of the "in between" of magic is science.*

This brings me to the second subject that may be a paradigm in the making: a unified physical theory, which might connect the somewhat polarized theories of physics today. You remember, in talking about the giant discoveries of the past, that Maxwell's Equations describe electromagnetism well; that Schroedinger's Equation describes quantum theory well; Einstein's Equations describe relativity well, and Newton's Equation of gravity still describes it very well indeed. However, in spite of some advances such as Gell-Mann's SU (3) development dealing with the mass ratios of some of the fundamental particles, *there is no theory which unifies all of these theories*. Furthermore, the press of experimental data keeps nagging at us: gravitational waves come from space from unknown sources for unknown reasons; high-energy machines discover particles and reactions faster than theory can predict; Dicke's measurements of the solar oblateness suggest that the now famous "proof" of Einstein's more general theory of relativity might be quite wrong; and even the mother of the sciences, astronomy, has produced two brand-new sources of energy in just one decade: quasars and pulsars, both of which are theoretically inadequately explained.

In face of the somewhat increasing inadequacy of existing theories to explain these data, there appears to be a small movement to carefully reconsider a previously rejected hypothesis: the ether concept—but, I must hasten to add, with significant differences. The old ether concept actually had its roots in Maxwell's Equations in the displacement current and in some of Hertz's thinking, but has been rejected for many decades because of the reasons shown in Table III. In the first place, it had to have weird properties. It had to carry the transverse vibrations of light with no loss as if it were a perfectly elastic solid, and yet could have no mass. Secondly, if the earth were continuously running into the stuff, it would have to slow down, and finally, everyone knows that the Michelson-Morley experiment proved

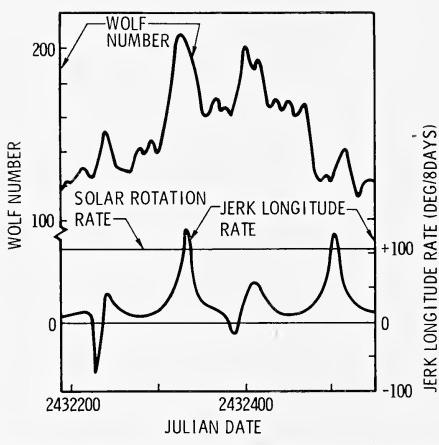


FIG. 4—Comparison of jerk longitude rate with Wolf number.

TABLE III
Popular Reasons Why Ether Won't Work

1. Earth would slow down
2. Michelson-Morley Experiment
3. Weird properties
4. Implies a preferred reference frame

that it couldn't exist. It finally got so complex to conceive of that it has been described as consisting of gears and cogwheels (16).

In the face of these apparent difficulties, however, some workers have been quietly doing some interesting things, as noted in Table IV: Nelson has come

TABLE IV
Recent Ether Progress

Contribution	Name	Date
Schroedinger equation	E. Nelson	1966
Probability density interpretation	J. G. Gilson	1969
Interpretation of Maxwell's equations	M. A. Jaswon	1969
Compatibility with relativity	T. G. Pavlopoulos	1969

up with a derivation of the Schroedinger Equation based on Newtonian mechanics with a pinch of statistical mechanics (17); Gilson has interpreted quantum-mechanical probability densities as the number density of subquantal particles (18); Jaswon has evolved Maxwell's Equations from ether assumptions (19); and Pavlopoulos expresses optimism for a way of circumventing the space-time relativity hurdle (20).

Let us consider, then, a new ether; not a complex one but a ridiculously simple one and see what we can get out of it. However, before we begin we

should eliminate the three objections of the old ether which I mentioned: we'll avoid the first one by not assigning it vibration properties *a priori*; for the second, the earth either has the choice of slowing down less than a detectable amount or of being made up of the ether as if it were a wave; and the Lorentz contraction of the lengths themselves neatly takes care of the third one.

And so let us finally look at the ether gas, a possible paradigm in the making, in Fig. 5. Any gas made of particles can be described by the extent to which they can occupy the same position or energy at the same time, and this results in different kinds of statistics, such as Bose-Einstein, Fermi-Dirac, or Maxwell-Boltzmann. (One is almost tempted to generalize that all statistical distributions were discovered by two people.) Without rejecting the others, let us consider the Maxwell-Boltzmann distribution, corresponding to non-spinning, non-overlapping particles. If the ether gas, if there is one, is described by this distribution, one would expect possibly that some speeds, like the mean speed or the root mean square speed, could be connected with experimental numbers. One such relationship emerges, shown in Fig. 6. The fine structure constant is one of the most important dimensionless constants in physics. Its value has never been deduced within experimental accuracy, and never using any sort of a physically-based model. You can see from the equation that *alpha* is given by the square of some velocity

MAXWELL-BOLTZMANN GAS

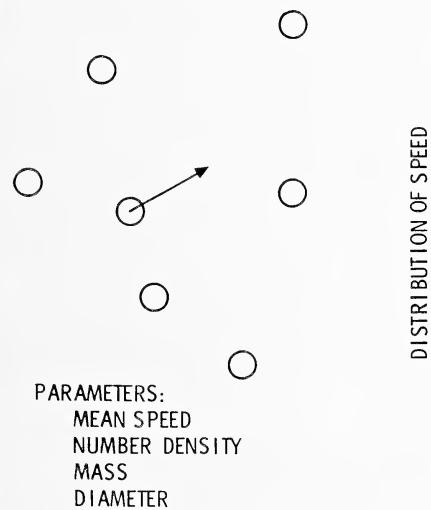


FIG. 5—Maxwell-Boltzmann distribution, corresponding to non-spinning, non-overlapping particles.

FINE STRUCTURE CONSTANT

$$\alpha = e^2/\hbar c$$

$$\alpha = \left(\frac{\text{RMS} - \text{MEAN}}{\text{MEAN}} \right)^2 \left[\frac{\text{MASS OF (PROTON + ELECTRON)}}{\text{MASS OF PROTON}} \right]$$

$$\alpha = 0.00729745$$

EXPERIMENT:

0.00729735 (REFERENCE 21)

0.00729720 (REFERENCE 22)

FIG. 6—Comparison of values for the fine structure constant.

ratios if corrected for the ratio of the electron to proton masses. This has intuitive appeal because experimental determinations of *alpha* sooner or later boil down to measuring the output of a hydrogen atom, which consists of one electron and one proton. Two different experimental values are shown (21, 22), both quite recent, and it is clear that this theoretical value (23) is closer to one of the experimental values than the other experimental value.

Well, you say, that's nice but how about a little more physical interpretation? Well, the best that can be seen now is two possibilities: the first one goes like this. The speed of the equivalent electron in a Bohr atom is *alpha* times the speed of light, corrected for the electron/proton mass ratio. If we interpret the first factor in Figure 6 as exactly the speed of the electron compared to the speed of light, we have explanation number one. The second one is that of saying that *alpha* is the ratio of the pressure inside an imaginary cube moving in the ether at the mean speed to the pressure on the outside of the same cube if the ether wasn't moving. This is a little unsatisfying, too, even if you understood it.

There are several other interesting little things which are emerging from studies of ether gases of this sort, such as mass ratios for some of the fundamental particles, new ways to interpret gravity, and comparisons with other experimental data.

However, the whole point of bringing out the discussion on a unified physical theory is not to wave the flag for an ether-like theory, because it might not be right . . . but to point out that if it is right, then it will share with many of the giant discoveries of the past several features: (1) it is not in vogue; (2) none of the people working on it are eminent; (3) it was already thrown out once; (4) it usually brings out emotional reactions. All of these features make me think that it has a good chance of being a winner.

Now last, as a possible paradigm in the making, I will touch briefly on ESP. This subject is a paradigm which is bigger than the other two because *it appears to conflict with a much broader base of science*. ESP is a strange world; it's a world where forward and backward in time doesn't seem to make much difference; it's a world where inverse square laws don't seem to work; electrostatic shielding has no effect (24). However, the statistics look very impressive, and if there aren't 100 percent hoaxes involved, they are awfully suggestive. To indicate how emotional it is, I will mention that in 1965, *Science* (which as you may know is a fairly conservative but very excellent science magazine) published an article by some research workers who were reporting extrasensory encephalographic communication between two identical twins, who were placed in nearby rooms with no communication between them (25). One of the two would flap his eyes and the equipment attached on the other twin would read something. The editor of *Science* got several letters from people wondering whether they should cancel their subscriptions. Others made some valid criticisms with respect to controls on the experiment. It is unfortunate that nothing more has been published in *Science* on the subject of ESP. I think Dr. Negus would have encouraged competent debate on this topic, and the American Association for the Advancement of Science was one of his special interests.

I shall comment on water dowsing just briefly. It might be related to ESP; it might be related to anti-gravity. Water dowsing is now being used by the Marines in Viet Nam, I understand, with considerable operational success, to find enemy bunkers that are underground. The technique is to take two coat hangers, straighten them out, make a right angle turn eight inches long and walk back and forth. When the hangers separate, it indicates the location of a bunker. Then they go down and dump grenades in it. They have been training Marines at Quantico and at Pendleton with this technique. There is an interesting experiment done by a scientist in France. He used an empty hallway, put a magnetic coil on the opposite side of this hallway to perturb the earth's field by about one-thousandth of the earth's field. He then hired ten water dowsers in France, who were purported to be the best, and asked them to walk up and down the hallway "doing their stuff." By and large, when the dowsers came to the place where the magnetic field was perturbed their sticks dipped. He moved the field around, and, sure enough, they said that it was in a different spot. Here is an interaction mechanism between a very tiny perturbation in the earth's field, a rod, and yourself; I don't know whether anyone has done any experiments like building a little dolly and putting a divining rod on it and seeing how many dynes of force result when you move it over an underground stream. It seems it isn't outside science to do that sort of experiment.

I think that this last possible paradigm in the making is a good example of the conflicts between logic and emotion. People tend to make rather *a priori* decisions on the basis of emotion rather than a logical

analysis of the "data." The reason for this, in my opinion, is that people are much more afraid of being too gullible than they are of being too skeptical.

We should not remove skepticism from science . . . because as Feynman has said, "The essence of science is doubt" (26). This is the quality which prevents science from going off in all directions at once and provides some measure of stability and quality. However, the greater the issue (the more sweeping the possible revolution), the more potential damage that is done by skepticism. I would be specific as follows: *far more harm is done to the progress of science by skepticism than by gullibility*.

In conclusion, let me talk about the action. I think everyone should have a few high payoff projects; by the same logic they should be low budget projects because the high payoff projects are the high risks projects, too. If you have a high payoff project I would be inclined to suggest that you select it on the basis of the following: First, get some non-eminent men; i.e., don't get eminent men, because they are not likely to find these discoveries. Second, make sure they have very *high imaginations* and that they have some *good level of competence*. Here you eliminate a lot of the crackpots, because most of the crackpots don't know how to use a differential equation. You should get the people who read science fiction, who read the quackery, who look for anecdotal data, and who also read *The Physical Review*. Remember, "A genius is a nut whose ideas were proved correct" (27).

In closing, the spirit of my message for change in science is perhaps captured in two quotations (28):

"All great changes are irksome to the human mind, especially those which are attended with great dangers and uncertain effects."

(John Adams)

And lastly from Bruce Barton:

"Action and reaction, ebb and flow, trial and error, change—this is the rhythm of living. Out of our overconfidence, fear; out of our fear, clearer vision, fresh hope. And out of hope—progress."

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Sand Waves and Tidal Channels in the Entrance to Chesapeake Bay

Abstract—Sand waves 5–12 feet in height and 200–1200 feet in length occur in water 25–50 feet deep in the sand bank and tidal channel area of the entrance to Chesapeake Bay. Most waves are asymmetrical in transverse profile, some facing with ebb currents, others facing with flood currents, depending on which is dominant at a given place. Steep slopes on the various waves range from 4° to 31° and average 12°.

The sand waves occur in association with tidal channels and especially on the flanks of shoals that form channel boundaries. Migration of sand waves, judged from their facing direction, is a bed sediment transport mechanism by which sand is moved up onto shoals.

Many large shoals of the area occur between ebb-dominated and flood-dominated channels. This implies the existence of net circulation loops of water and sediment in cells located over shoals. The action of such cells is to trap sediment. Other ebb-flood shear zones may mark sites of future shoaling in the entrance.

Introduction

Tidal channels and sediment deposits on their beds are adjusted to a state of quasi-equilibrium with the velocity fields of ebb and flood tidal currents. Because of this adjustment, investigation of both channels and bed forms yields important clues to the kinematics of the formative tidal flow. Size, shape, curvature, and pattern are significant channel characteristics. Asymmetry, depth of occurrence, and relationship to nearby shoals are among the bed form characteristics that warrant observation.

The present study deals with channels and bed forms in the tidal entrance to Chesapeake Bay. It appears that the evolution of shoals in the entrance is related, at least in part, to migration of large bed forms or sand waves that occur in tidal channels and atop nearby shoals. Practical significance of the findings relates to improved knowledge of tidal circulation through an estuary entrance, to channel maintenance, and to residence time of particulate contaminants in entrance shoals.

In those bays and estuaries where the range of the tide is limited, shoals and bed forms are not exposed for observation at low tide. Morphometric study in such instances is customarily done by some form of echo sounding.

Previous Investigations

Sand Waves. These moveable bed features, as known from other areas, superficially resemble sediment ripples but are of mammoth proportions. Crest spacing is often several hundred feet, but spacings up to several thousand feet are known (1). In height sand waves commonly measure 15 to 25 feet, but heights up to 85 feet have been reported (2). Profile shapes vary from symmetrical or trochoidal to strongly asymmetrical. Symmetrical profiles occur when currents in the overlying water are oscillatory and of the same strength and duration in both directions. Asymmetric profiles occur when there is an inequality in the overlying oscillatory flow or when the flow is unidirectional. Symmetrical forms migrate very slowly, if at all. Asymmetrical types migrate with speeds that range from a fraction of a meter per month as, for example, at the mouth of the Loire estuary, France (3), to 2100 feet per day as, for example, in the Brahmaputra River at Aricha, East Pakistan (4).

Marine sand waves are nearly always associated with tidal currents and a flow constriction of some kind, either horizontal or vertical, that results in increased current velocity. Estuary entrances thus are common sites for sand waves as, for example, in San Francisco Bay inside Golden Gate (5), at the tidal entrance to Delaware Bay (2), the Bay of Fundy (6), the mouth of the Thames estuary (7), and the mouth of Bristol Bay, England (8). Sand waves abound in the English Channel (9), the Irish Sea (10), and the Persian Gulf (11).

Tidal Channels. Deposition of sediment on the bottom of a shallow water body subject to tides ultimately produces a pattern of shoals and intervening tidal channels. In studies in the tidal lagoons of Holland, these channel configurations, as seen in map view, have been compared to branching patterns of trees. There is a dendritic, apple tree pattern and there is a linear, slender poplar pattern (12). In English estuaries Cornish (13) among many others noted that tidal flood flow took a direct, short-cut path towards the head of the estuary and in so doing moved up and over shoals and shallow flats. Ebb flow, on the other hand, tended to be somewhat more confined to the deeper main mean-

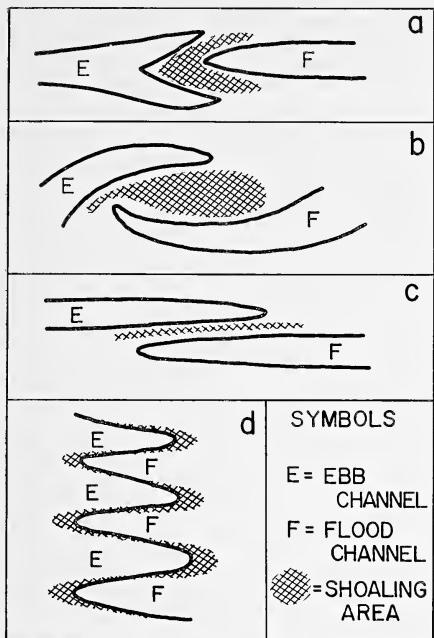


FIG. 1—Four idealized arrangements of interdigitating ebb and flood tidal channels as seen in map view. Mutual evasion of ebb and flood channels is the underlying motif. A, forked channel with parabolic shoal; B, flanking channels with airfoil-shaped shoal; C, parallel channels with linear shoal; D, wide estuary pattern with zig-zag shoals.

dering channels. Maximum flood and ebb flows even within the same channel tended to follow different, mutually evasive paths.

Mutual evasion results in at least several distinct arrangements of interdigitating ebb and flood channels and associated shoals (Fig. 1). A flood channel is open to flood currents and hence is one in which maximum velocity occurs during flood flow; an ebb channel is one open to ebb currents and hence one in which maximum velocity occurs during ebb flow. Water in the channels and over the shoals experience tidal reversal at all depths.

Relations Between Sand Waves and Tidal Channels. Bed forms developed on the bottom of many tidal channels are subjected to reversing currents that are both stronger and of greater duration in one direction than in the other. Sand waves constructed under these conditions are, as a result, asymmetrically in profile. Although small current-generated sediment ripples on the bottom may be reversed in their facing direction by each ebb and flood flow, the larger bed forms of sand wave size, say 20 feet or more in wave length, apparently maintain their

facing direction (14). Asymmetry in sand waves is manifested in a short, steep (15–30°) sediment slope which forms one side of the sand wave and by a longer, more gentle slope which forms the other side. Relative to the flow direction of the net or residual current, the steep face is on the down-current side of the sand wave. Thus in many flood and ebb channels sand waves face and migrate towards the closed or shallow end of the channel (14, 15).

In some tidal waterways (3) during the rainless season, sand waves are stationary except for their crests which move back and forth with ebb and flood currents. With the advent of rains in the hinterland freshwater discharge increases and the associated downstream current flow augments the ebb tidal current velocity to a point where downstream migration of the sand waves begins.

Field Area and Methods

The present study was performed largely in the northern part of the tidal entrance to Chesapeake Bay. In the northern one-half of the entrance, in an area 5x5 nautical miles, charts and echo sounding of the bottom show a prominently developed pattern of shoals and interfingering tidal channels.

Greatest water depth found in any of these tidal channels was 60 feet. Water depth atop the shoals ranges from 3 to 15 feet. Average water depth over the area is approximately 25 feet at mean low water.

The tide in this region is of the semidiurnal (equal) type. Mean tidal range at Fisherman Island on the north side of the entrance is 3.0 feet. The range of spring tides is 3.6 feet. Duration of falling tide, 6.4 hours, exceeds the duration of rising tide, 6.0 hours, in the area under study and generally along the Eastern Shore.

Tidal currents are rather poorly known over the sand banks and in the channels. Peak surface currents due to astronomical tides alone average over a year between 1.5 to 2.0 knots. Annual maximum forecasted tidal current is 3.4 knots on both ebb and flood. These maximum currents occur in North Channel, the deepest and principal tidal channel of the study area. Timing of tides and currents is such that maximum surface tidal currents are nearly simultaneous with the times of high water and low water. This correspondence indicates a tidal wave of the progressive type.

Swells come usually from the quadrant between northeast and northwest with the former direction more common than the latter. Wave period averages 5.3 seconds and wave height averages 1.6 feet (16). Refraction of wave crests and changes in wave height on entrance into shoaler water produce substantially different local wave climates in various parts of the channel and bank area. Storm waves constitute a separate and important element of the local wave climate.

Position in the entrance was determined using a method in which horizontal angles are measured by sextant between three landmarks and plotted with a 3-arm protractor. Location accuracy of this method is ± 30 feet under good conditions and ± 50 feet under poor conditions. Water depth was recorded

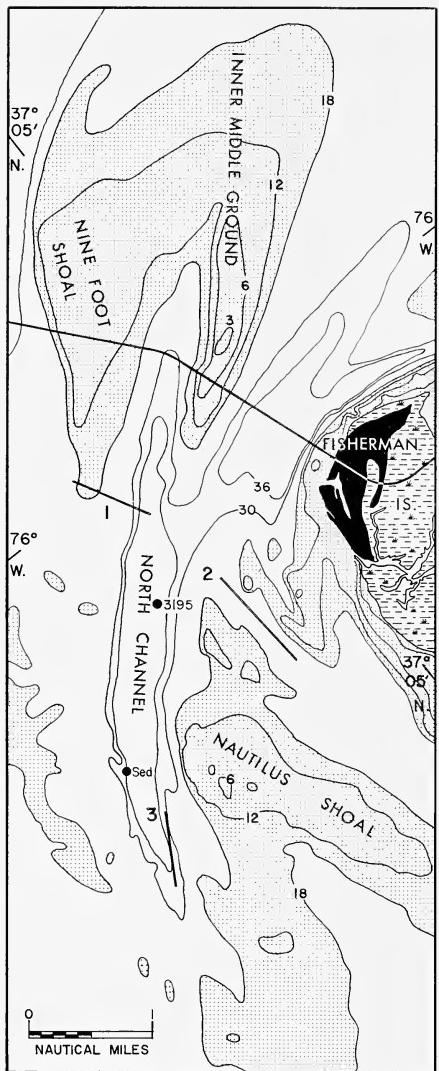


FIG. 2—Shoal and tidal channel bathymetry in the northern part of the entrance to Chesapeake Bay. Numbered profiles are shown in Fig. 4. Current measurement and bottom sampling sites are shown.

by echo sounding at 80 kHz with a transducer whose acoustic cone angle is 8° . Sediment sampling was

done using a grab sampler that takes a shallow semicylindrical shaped scoop of the bottom.

Channels and Bed Forms In the Sand Bank Area of Chesapeake Bay Entrance

Within the area and environment described above there are three tidal channels and associated large bed forms that together clearly illustrate both the diversity and harmony of relations between tidal channel flow and sediment deposition. One of the channels is situated between Nine Foot Shoal and Inner Middle Ground (Fig. 2). A second channel is between Nautilus Shoal and Fisherman Island. The third and master tidal waterway is North Channel which passes out to sea close to the southern margin of Nautilus Shoal.

Tidal Channels. The first of the three channels is open to flood tidal currents, but is shielded from ebb currents. It is the straight, unforcked tongue of the ebb-flood channel pair of the type illustrated in Fig. 1a and is classified as a flood channel. Maximum water depth in the channel is 45 feet. The depth decreases with distance landwards towards the head of the channel. At the crests of the shoals on either side near the blockaded end of the channel, water depths are between 2 and 8 feet. Width of the channel is approximately 6000 feet and length is approximately 2.5 nautical miles. In transverse profile the channel is V-shaped with a rounded vertex. Maximum side wall slopes measured from a horizontal plane are 1 degree. The angle of bifurcation between the subject channel and the master channel is 32 degrees.

The second of the three channels is open to ebb tidal current flow. Besides this difference when compared with the first channel, this present narrow passageway leads into a "gut" or area of deeper water surrounded by shallows. Maximum water depth in the "gut" is 37 feet. Outside the entrance to the "gut" similar water depths are found. In the entrance passageway itself, sill depth is approximately 25 feet. Width of the entrance channel is 1800 feet, whereas width of the "gut" is approximately 1 nautical mile. Thus the channel in question is constricted both vertically and horizontally. The length of the constricted section is 1 nautical mile. Side wall slopes are less than 1 degree. The angle of bifurcation between the passageway channel and the master channel is 45 degrees.

The third of the three channels, North Channel, is considerably larger than the other two. It is 8 miles long, 0.8 mile wide, and up to 56 feet in depth. In plan the channel is curvilinear. The branching pattern of side channels is of the poplar tree type; however, unlike an actual tree, some side branches extend upwards (i.e., landwards) while others extend downwards (i.e., seawards). Of the two types of branches to the main channel, the first mentioned are flood channels, the second are ebb channels. Duration and maximum velocity of ebb and flood currents at the bottom of the channel indicate that it should be classified as a flood channel. Depth over the bar at the channel mouth is approximately 20 feet. Grain size of the bottom sediment

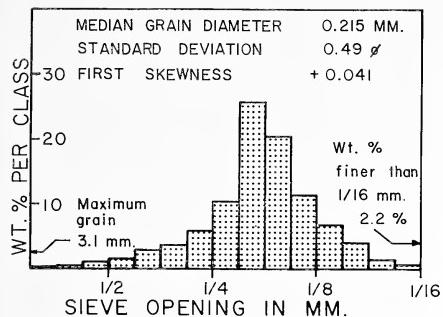


FIG. 3—Particle size frequency distribution of bottom sediment in a part of North Channel. Sampling location is shown in Fig. 2 at the point designated "Sed."

in a part of North Channel is shown in Figure 3. At this point, texturally the sediment is a moderately well-sorted fine-grained sand.

Sand Waves. Prominent sand waves were found on the flanks of Nine Foot Shoal (Fig. 2 and Fig. 4, Profile 1). The features average 5 feet in height and 250 feet in wave length. They are asymmetrical and face to the WSW in the general direction of the flood tidal current. Upslope advance is suggested by this orientation. The crests of the sand waves seem to be nearly parallel to the ridge crest of Nine Foot Shoal judging from the changed appearance of the wave train on other profiles surveyed in the vicinity. The angles of inclination of the steep faces range from 4° to 14° and average 9°. Smaller waviform features are evident on the echo sounding profile on the deeper slopes that lead up from the bottom of North Channel towards the crest of Nine Foot Shoal. Sand waves terminate abruptly 1200 feet from the ridge

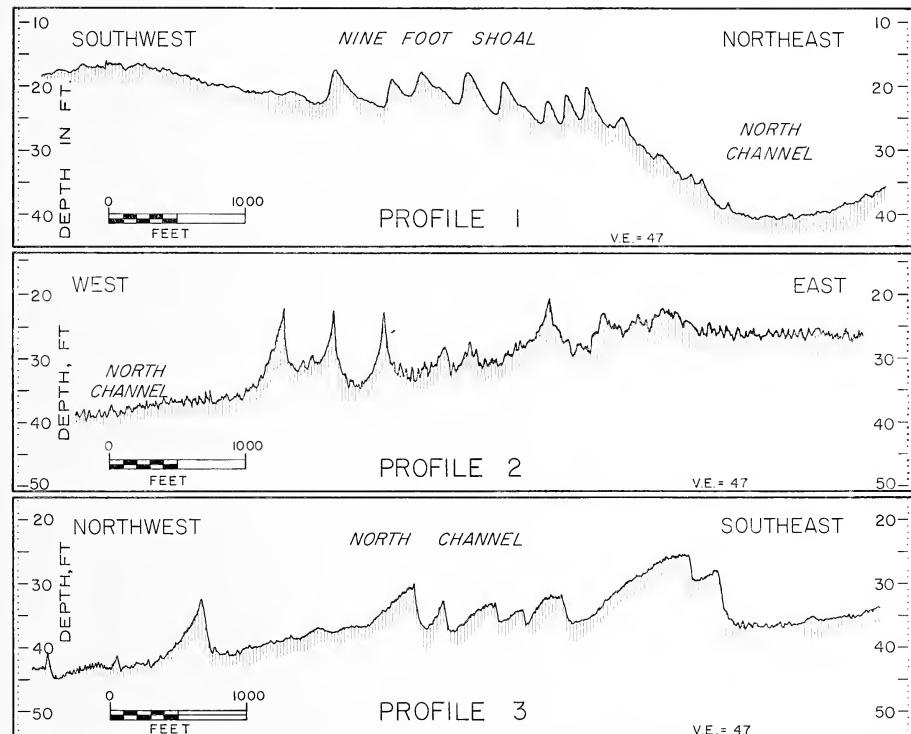


FIG. 4—Echo sounding profiles of the bottom showing sand waves on three profiles. Locations of the profiles are shown in Fig. 2.

crest. Water depth over the tops of the leading sand waves and water depth at the ridge crest are nearly equal, about 17 feet. Sand waves are not seen on the west side of the ridge crest.

Sand waves also occur in the channel between Nautilus Shoal and Fisherman Island (Fig. 2 and Fig. 4, Profile 2). The features are up to 12 feet in height and 300 feet in wave length. In profile the sand waves are asymmetrical-trochoidal with slightly steeper slope inclinations on the east side. These steeper slopes among the different prominent waves range from 10° to 31° and average 19° . The sand waves face with the ebb tidal current. Sand waves are absent both on the North Channel side of the tidal passageway and also in the "gut" beyond the constriction. Minor irregularities on the profile are due to surface water waves, the average height of which was 1.5 feet on the date of survey. Crests of the prominent bottom features are believed to be arcuate in plan, convex to the east. This geometry is suggested by a pattern of sand wave caused disturbance observable at the water surface.

The seaward end of North Channel is a third area in which sand waves of still a different orientation and form are developed (Fig. 2 and Fig. 4, Profile 3). These features range in wave length from 200 to 1200 feet and range in height from 2 to 12 feet. All of the forms are asymmetrical in profile and face seaward with the ebb tidal current. Angle of inclination of the steep faces range from 6° to 13.5° and average 9.5° . The largest feature on the profile represents a crossing over one of the ridges that extends out to the west into North Channel from Nautilus Shoal. These ridges thus at least superficially resemble sand waves or compound sand waves and are distinctly asymmetrical. The troughs between ridges are ebb channels. The top of the large ridge of the figure is double crested where crossed.

Discussion

Speed of current flow is least near a sediment bed owing to frictional effects and increases with distance away from the boundary. Shear stress on the bed, τ_0 , a vector quantity which is significant in estimating the movement of the bed sediment (17), is proportional to the rate of velocity increase away from the bed. Current speeds conventionally in studies of estuarine tidal flow, are illustrated as a sinusoid on coordinates of surface speed versus time. Flood currents are plotted above the zero velocity line, ebb currents below. But for judging sediment movement at the bed, a more relevant plot (Fig. 5) would be the sinusoid of bed shear stress against time. When τ_0 was seen to exceed a critical magnitude, τ_c , required for sediment movement, it could be assumed that bed sediment was actually moving and in the indicated direction, either ebb or flood. Given the distorted, unequal, and asymmetrical velocity sinusoids characteristic of ebb and flood tidal channels (18, p. 168; 19, p. 344), it is likely that shear stress sinusoids are similarly distorted. Thus in tidal channels, sediment transport at the bed can be equal in ebb and flood directions or nearly unidirectional despite appearances of the reversing tidal flow at

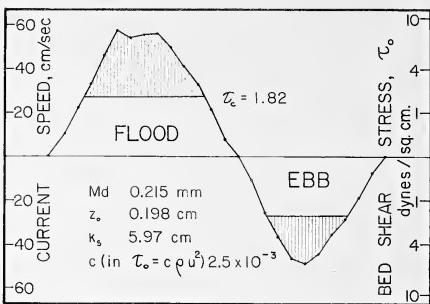


FIG. 5—Tidal current speeds in North Channel, USC&GS station 3195, October 16–19, 1963. Total depth, 56 feet. The curve is for observed current speed 18.5 feet above the bed and also for estimated shear stress, τ_0 , at the bed. Observed speeds were corrected to mean tidal range and averaged over six cycles. M_d is the median diameter of the bed sediment (Fig. 3), z_o is the roughness length estimated from vertical velocity profiles, k_s is the height of bottom roughness elements deduced from z_o , and T_c is the critical shear stress, calculated from the Shield's entrainment diagram.

the water surface. As shown in Fig. 5, for North Channel, under the assumptions made, calculated shear stress at the bed exceeds estimated critical shear stress for the sediment on both the flood cycle and on the ebb cycle, but flood-directed transport is dominant in magnitude and direction. North Channel at this location is thus classified as a flood channel.

Over the larger area of the entire entrance to Chesapeake Bay, a striking pattern emerges (Fig. 6) when available Coast and Geodetic Survey data on the speed, direction, and duration of near-bottom tidal currents are coupled with observations of channel and shoal morphology, and knowledge of sand wave facing direction. The patterned areas, shown in the figure, in and along channel bottoms also extend up into re-entrants into the margins of shoals. In the figure certain of the patterned areas are characterized by a flood duration of bottom current in excess of ebb duration of bottom current. In other patterned areas, ebb duration of bottom tidal currents exceeds flood duration of bottom current. Dominance is shown by the larger arrows. In unpatterned areas the durations of the two bottom currents are approximately equal. Relative duration of currents is not shown atop shoals. A flood or ebb dominance in bottom currents in a patterned area implies a corresponding flood- or ebb-directed net transport of bottom sediment in the same area.

In moving across the figure from northeast to southwest, there is a marked tendency for flood-dominated and ebb-dominated channels to occur alternately. This large spatial arrangement is modified locally by ubiquitous and small scale dead-end channel bifurcations. It is seen that shoals are commonly situated with a flood channel on one side

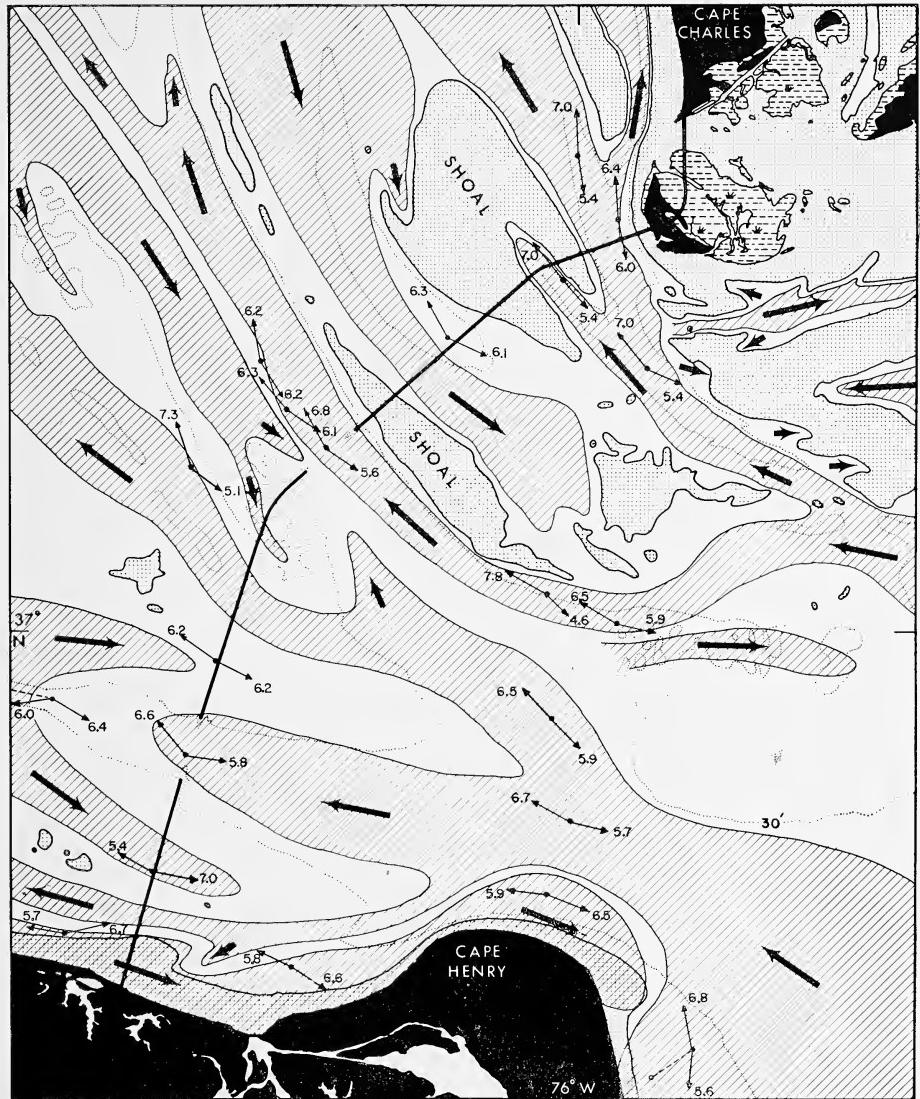


FIG. 6—An hydraulic and geomorphic interpretation of the net nontidal (residual) flow pattern at the bottom in the entrance to Chesapeake Bay. Numbers are measured flood and ebb flow durations at the bottom in hours; small arrows show measured direction of near-bottom currents. Stippled areas are shoaler than 18 feet. Ruled areas show where there is an ebb or a flood flow predominance. Large arrows indicate which is predominant. Non-patterned areas are neutral.

and an ebb channel on the other. The large parabolic shoals and cigar-shaped shoals of the figure are obvious examples of this arrangement. Even where shoaling has not built up above the 18-foot isobath, the shape of the deeper contours reveals evidence of deeper shoaling at locations between ebb- and flood-dominated channels. Such a diagram may therefore have some value as a device for predicting the location of areas of future shoaling.

The location of shoals between channels which are reversed in sense of sediment transport direction is not inconsistent with the existence of a net circulation of sediment in a cell, the center of which is more-or-less over the main part of the shoal or some part of the shoal. Since there is probably an ebb dominance of flow over the tops of the major shoals of the entrance (20), the postulated sand circulation cells may be off center with respect to the shoal top. From close examination of shoal morphology, it appears that one of the two net flows moves sediment diagonally and upwards onto the shoal thereby forming a gently rising slope on the shoal flank, whereas the other marginal net flow moves longitudinally along the steeper flank of the shoal. Shoal migration is believed to be in the dip direction of the steep flank.

If sand circulation cells or closed loops do exist in fact as a result of the net or residual tidal flow in the entrance, sediment traps or accumulation sites are thereby produced over the shoals. Sediment passing by, if once drawn into the cell, would have a tendency to remain there, thus adding to the shoal size. Sand waves and smaller undulose features are probably important forms by which sediment is moved up, onto, and around the shoals.

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A Winter Limnological Study of Lake Wilcox: A Freshwater Impoundment

Abstract—A fourteen week winter limnological investigation was conducted on Lake Wilcox from January 22 until April 23, 1969. The purpose of the study was to gain information concerning the winter populations of phytoplankton and zooplankton as well as the winter biological productivity and the winter contents of oxygen, calcium, iron, nitrate nitrogen, phosphate phosphorus, hydrogen-ion concentration and bicarbonate alkalinity. Physical factors such as temperature, light penetration, lake area and watershed soils were also of importance to the study.

All sampling was conducted at one sampling station. Water temperatures were at equilibrium from surface to benthos at the start of the study, with surface, 3 meter and 5.5 meter depths showing continued separation as the study progressed toward spring and summer conditions. A high allochthonous tripton load limited the Secchi-disc transparency to 0.8 m or less throughout the study. Iron was found in low quantities (1.0 to 3.5 ppm), the majority of which was believed to be contributed by the tripton. Phosphates were generally low (0.06 to 0.25 ppm at surface, 0.06 to 0.23 ppm at 3 m, and 0.06 to 0.29 ppm, benthic), although never attaining nil quantities, and showed slight increases following each rainfall.

Hydrogen-ion concentration and bicarbonate alkalinity showed Lake Wilcox to be neutral to slightly alkaline, which is characteristic of a medium-water lake. Recorded calcium was quite low with a maximum of 9.4 ppm during earlier sampling dates under winter conditions, and decreased to 3.3 ppm under spring conditions. Dissolved oxygen showed equilibrium at early sampling dates with separation between the three depths occurring as the study progressed toward spring conditions.

Plankton populations were generally negligible, with only a few different genera observed from a large volume of filtrate. Winter phytoplankton genera consisted mainly of diatoms, and zooplankton genera were primarily rotifers. Winter samples showed the zooplankton in greater quantity than the phytoplankton, but this condition reversed as spring conditions arrived. Because of the negligible populations of plankton, productivity could not be measured.

Introduction

The objectives of this investigation were to gain basic information concerning the winter conditions of the plankton and benthic organisms; chemical factors of oxygen, alkalinity, hydrogen-ion concentration, calcium, nitrate nitrogen, phosphate, iron; physical factors of light penetration, temperature,

area, depth, width and length, geologic factors of watershed and lake basin form. Also an attempt was made to measure the biological productivity of the lake under winter conditions.

Limnological investigations have increased considerably over the last ten years probably as an indirect result of the concern for the abatement of pollution of rivers, lakes, and streams. Results of this pollution can be seen in terms of fish kills and migratory bird population depletion as well as boating and swimming recreational facilities being destroyed each year.

The shortage of limnological studies on the freshwaters of Eastern Virginia and the complete lack of published information concerning the winter conditions of these waters have led to such a study in this area. Some winter limnological studies have been conducted in the west and mid-west regions of the United States (1, 2), but published literature reveals that no similar studies have been undertaken in the central plateau region of Virginia.

Description of the Lake

Lake Wilcox (Fig. 1) is an artificial lake located $77^{\circ} 24'$ west longitude and $37^{\circ} 12'$ north latitude and covers an area of 6.15 ha. The lake basin is 31.7 m above mean sea level and is long (1,126 m) and narrow (152.2 m), with banks on the east, west



Fig. 1—Lake Wilcox, Virginia, looking north; October.

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and south boundaries ranging from 6.4 m to 18.6 m in height. The north end of the lake is also protected by banks ranking within the aforementioned range; however, they do not form the immediate northern boundary. The dominant forms of vegetation growing on these banks are oak, pine and shrubs. The leaves from these and other minor vegetative forms fall into the lake, especially in the autumn. The deepest part of the lake is 5.5 m, and this is limited to the north portion. As one progresses toward the south part of the lake, the depth gradually decreases to 1.0 m where the lake joins a swampy area (Fig. 2).

Lake Wilcox was formed in 1898, when a dam was constructed across the stream to form a water reservoir to supply the City of Petersburg. Shortly after its formation, it became inadequate as a water supply due to insufficient volume, and was then, through minor alterations of the north shore and dumping several tons of sand on the bottom of the north end, converted to a public swimming facility. In 1953, following political problems involving usage of the lake, it was closed and not used again until 1963, when it was stocked with fish and opened as a city-owned public fishing facility. It is for this purpose that it is used today and has been restocked with fish only one other time.

The watershed for Lake Wilcox covers an area of 1,327 acres and is composed of two soil associations. The Atlee-Dunbar Association comprises 66% of the periphery of the watershed. Atlee, which accounts for approximately 60% of the association, is a moderately well-drained (iron is in the oxidized state) soil with a 20 to 26 cm surface of very fine, gray-brown sandy loam. The subsoil, below 39 cm, is yellow-brown mottled, gray clay loam. Dunbar occupies approximately 2% of the slopes of the upland flats and accounts for 30% of the association. It is a poorly-drained (iron is in the reduced state) soil, with a 15 to 26 cm surface of dark gray-brown, very fine, sandy loam. The subsoil is firm clay loam to silty clay. There are no water soluble minerals in this association.

The Loamy and Gravelly Sediments—Norfolk Association composes 34% of the watershed and is found adjacent to the lake. This association is of a miscellaneous land type containing well-drained soils of yellow-brown, loose, loamy fine sand and gravel

with pockets of clays and possibly thin layers of ferruginous sandstone. Again there is only a very small amount of water soluble minerals which would contribute to the chemical status of the lake.

The feeder streams, which enter the lake in the south end, originate from two very small ponds located on higher ground in the watershed. These ponds frequently dry up during the summer months, thereby contributing water to the lake only during periods of rain. Because of house and road construction conducted in the south portion of the lake, one of the feeding streams has almost been eliminated and the extreme south portion of the lake has been filled with soil and is now a swampy area.

Outflow is controlled by the use of a 24 inch pipe located at the top of the dam which is on the north end of the lake. This pipe is open all the time and the outflow is minimal. No emergent vegetation was noted in any portion of the lake at the time of the study.

Methods and Materials

Physical:

Temperature. Air and water temperatures were recorded by means of a Taylor maximum-minimum thermometer in degrees Fahrenheit and converted to Centigrade with tables (3). Air temperature was recorded first, when the thermometer was dry, and then the index were set on the ends of the mercury columns prior to immersion into the water. Following a 3-5 minute interval, the thermometer was returned to the surface and the reading was recorded. Temperature was taken at the surface (upper 0.2 m, just below the surface film), 3 meters, and at the bottom or 5.5 meters. Although the water level in the lake did fluctuate from time to time, there was no appreciable change in the depth of the water so this factor was disregarded.

Light penetration. A Secchi-disc, 20 cm in diameter, was used to determine the limits of visible light penetration. The procedure consisted of lowering the disc into the water on the shaded side of the boat and noting the depth at which it was no longer visible, then lifting the disc and noting the depth at which it reappeared. The average of these two readings was considered the depth of penetration of visible light or the Secchi-disc transparency. The shadow cast by the boat did not interfere with the visibility of the disc.

The validity of the Secchi-disc transparency in this particular lake is of some question because the lake contained a reasonably heavy load of suspended clay particulate matter and Ruttner (4) observed that under these conditions the water can be quite well illuminated as if under ground glass, even though there is a high level of opacity.

Determination of the total above-surface illumination was made using a Weston Electrical Instrument Corporation photronic cell. Its range of sensitivity is close to that of the human eye; therefore, it gives only a partial measure of the infra-red and ultra-violet rays. It was used in this investigation as an indication as to the amount of solar radiation striking the water surface in relation to the observed Sec-

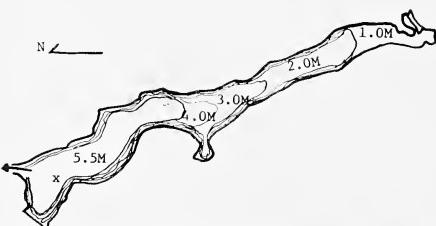


Fig. 2—Depth contours of Lake Wilcox, Virginia; x denotes sampling station. Length of lake, 1,126 m; maximum width of lake, 152.2 m.

chi-disc transparency. Since data collections were made at approximately the same time each week, the only changeable factors were cloud cover and elevation of the sun due to the change of seasons from winter to spring; however, the change in elevation of the sun produced no noticeable change in the photonic cell readings.

Hydrographic mapping. An aerial photographic map number J—8, revised December 11, 1964, and scaled one inch for 200 feet, was purchased from the City of Petersburg. Maximum length and maximum width were determined with measurements taken from this map. Area was determined by using a polar planimeter and tracing a 1951 aerial photograph scaled one inch equaling 40 acres. The photograph is on file at the Prince George County United States Department of Agriculture Soil Conservation office. The area of the watershed was also made from this photograph.

Maximum depth was measured with the use of a calibrated line with an eight pound weight secured to one end. Because the lake is a stream bed, what was thought to be the deepest portion was traversed in a definite pattern with soundings made at definite points and continuing upstream in a similar manner.

Chemical:

A 1200 cc modified Kemmerer water sampler was used to remove all water samples from the lake at one sampling station located 7.915 m from the west on the north end of the lake. After samples were taken at the desired depth, they were packed in ice and returned to the laboratory at Virginia State College for analysis. The time difference between sampling and analysis was never greater than 30 minutes, so no appreciable changes in the samples occurred from the lake to the laboratory.

Dissolved oxygen. The standard modified Winkler method as outlined by Welch (3) was used to determine the dissolved oxygen content of the three depths of water sampled. Measurements were recorded as parts per million (ppm).

Alkalinity. Methyl orange alkalinity was used to determine the quantity of carbon dioxide present in the bicarbonate form. Standard buffer solutions of pH 4.0 and 8.0 with methyl orange added were used for comparison in order to better determine the exact color tint sought in the titration. This method is also outlined in Welch (3).

Hydrogen-ion concentration. All readings of pH were taken in the laboratory using a Beckman Zero-matic pH meter.

Iron, calcium, phosphate and nitrate. The Commonwealth of Virginia Water Control Board at Richmond, Virginia, agreed to analyze the samples for iron, phosphate, calcium and nitrate because they were currently involved in collecting these data from as many sources as possible in the state as part of their pollution control efforts. Samples were transported to the water control board packed in ice, immediately after being taken from the lake. The time involved to transport these samples was less than 45 minutes, so no preservatives were added to the samples.

Biotic:

Plankton. Plankton samples were taken with a number 20 mesh Wisconsin Style Plankton Net made from nylon bolting cloth with 173 threads per inch. Vertical hauls were made by allowing the plankton net to sink to the bottom and then retrieving it to the surface. Samples were returned to the laboratory and kept under refrigeration and analysis was made within 24 hours after procuring the sample. No preservatives were added to the sample because of this short time period.

Using the formula to find the volume of a cylinder, with the diameter of the net being 12 cm and the height of the cylinder being 5.5 m, the total volume of water filtered was 7,760 liters. The total number of organisms per sample was still relatively small but adequate for analysis.

Analysis of plankton concentrates. The number of different organisms present and the quantity of these organisms have definite value for a limnological study; however, because this is the first study conducted with limnological intentions on this body of water, the investigators were more concerned with the presence of various organisms rather than proportionate numbers. Also, because of the high tripont load, volumetric and gravimetric analysis of the plankton samples would have been difficult. However, some attempt to indicate a number relationship was made by indicating the occurrence of the organisms in the field of view of the microscope as viewed under the low power (10X) objective. Organisms that occurred once in the field per sample were listed as being rare (R), those that occurred 2 or 3 times were listed as few (F), 4 or 5 times were listed as many (M) and 6 or more times as predominant (P) (Tables I and II). The microscopic organism *Daphnia* sp. was not classed in this manner for the obvious reason of size. Instead, it was listed as the number of organisms per ml of concentrated sample and presented separately (Fig. 11). Taxonomy was not a primary intention of this investigation; organisms were classified only on the basis of genera.

Benthos. Benthic samples were made with the use of a 6 x 6 inch Eckman style dredge. This was lowered to the bottom with the jaws open and upon closing, was raised to the surface. The sample was then emptied into a screened bottom wash bucket where the bottom ooze was removed through washing, leaving the organisms on the 30 mesh wire cloth. Some of the ooze and water were retained for microscopic analysis. The macroscopic organisms (fauna) were counted at the sampling site due to their presence in small numbers. Organisms were recorded as the average number per dredge sample.

Benthic samples were made every other week, due to the stability of the benthos and also because of the time element required to obtain a proper sample count. On each sampling date, four dredge samples were taken. The organisms were counted in each sample and the numbers were averaged to list the occurrence of the organisms as the average number per dredge sample. No microscopic organisms were found present upon laboratory analysis.

TABLE I

Genera of Zooplankton present in Lake Wilcox with their relative abundance on each sampling date

Genera	1-22-69	1-22-69	2-5-69	2-12-69	2-19-69	2-26-69	3-5-69	3-12-69	3-19-69	3-26-69	4-2-69	4-9-69	4-16-69	4-23-69
<i>Acauthocystis</i>	M	M	F	R	R	—	R	F	F	R	R	R	—	F
<i>Asplanchna</i>	—	—	—	R	—	—	R	—	—	—	—	—	—	F
<i>Blepharisma</i>	—	—	—	—	—	—	—	—	—	—	—	—	—	M
<i>Bosmina</i>	M	M	M	—	M	M	M	M	M	P	R	M	—	—
<i>Canthocampus</i>	—	—	F	—	—	—	—	—	—	—	—	—	—	—
<i>Couchochiloides</i>	—	—	—	—	—	—	—	—	—	—	F	F	—	—
<i>Couochilus</i>	—	—	—	—	—	—	—	—	—	—	R	—	—	—
<i>Cupelopagis</i>	—	—	R	—	—	—	—	—	—	—	—	—	—	—
<i>Cyclops</i>	F	F	M	F	M	M	M	M	R	F	F	M	M	F
<i>Diaptomus</i>	F	—	F	P	P	—	—	F	F	—	—	—	—	—
<i>Difflugia</i>	—	—	—	—	—	—	—	—	—	—	F	—	—	—
<i>Filina</i>	—	—	—	—	—	—	—	—	—	—	—	—	—	R
<i>Foscularia</i>	R	—	—	—	—	—	—	—	—	—	—	—	—	—
<i>Gastropus</i>	—	—	—	—	—	—	—	—	—	—	M	F	—	—
<i>Kellieottia</i>	R	R	R	—	M	F	M	M	M	F	M	—	—	F
<i>Keratella</i>	P	F	F	M	M	P	P	P	P	P	P	P	P	P
<i>Mallomonas</i>	—	—	—	—	—	—	—	—	—	—	F	—	—	—
<i>Nauplius</i>	M	P	M	M	P	F	M	M	M	F	F	—	F	M
<i>Peridinium</i>	—	—	—	—	—	—	—	—	—	—	R	—	—	—
<i>Polyarthra</i>	—	—	R	—	R	—	F	—	—	—	F	R	F	F
<i>Sphyriatas</i>	P	P	P	P	M	M	M	M	M	M	M	—	—	M
<i>Spirostomum</i>	—	—	—	—	—	—	—	—	—	—	—	—	—	M
<i>Synchaeta</i>	—	—	—	—	F	—	M	—	—	M	M	F	F	F
<i>Testudinella</i>	—	—	—	—	—	—	—	—	—	—	R	—	—	P
<i>Trichocerca</i>	—	—	—	R	—	—	—	—	—	—	—	—	—	—
<i>Vorticella</i>	—	—	—	—	—	—	—	—	—	—	—	M	—	—

R = rare

F = few

M = many

P = predominant

An easy method used to count the translucent *Chaoborus* sp. was to place a circle of porous black construction paper, cut the same diameter as the bottom of the wash bucket, below the organisms as they floated on the surface of the water in the wash bucket after the bottom ooze had been washed away. As the bucket was raised out of the water, the water in the bucket filtered through the paper leaving the organisms behind to be easily counted.

Productivity. Primary biological productivity was measured according to the method of oxygen production and oxygen consumption, as described by Odum (5). A light bottle (transparent) and a dark bottle (opaque) were filled with a water sample taken with the water sampler from 0.2 m below the surface of the water. The bottles were then sealed and suspended at a depth of 0.2 m from two floats on the surface. Both samples were left suspended in

TABLE II

Genera of Phytoplankton present in Lake Wilcox with their relative abundance on each sampling date

Genera	1-22-69	1-29-69	2-5-69	2-12-69	2-19-69	2-26-69	3-5-69	3-12-69	3-19-69	3-26-69	4-2-69	4-9-69	4-16-69	4-23-69
<i>Anabaena</i>	—	—	—	—	—	—	—	—	—	—	R	—	—	—
<i>Closterium</i>	—	—	—	—	—	—	R	—	—	—	—	—	—	—
<i>Coelosphaerium</i>	—	—	—	—	—	—	—	—	—	—	—	—	—	R
<i>Cymbella</i>	—	—	—	—	—	—	—	—	—	—	—	—	F	—
<i>Desmidium</i>	—	—	—	—	—	—	—	R	R	—	—	R	M	F
<i>Dinobryon</i>	—	P	M	M	P	F	P	P	P	M	P	R	—	R
<i>Euglena</i>	—	—	—	—	—	—	—	—	—	—	M	M	M	M
<i>Eutiotia</i>	—	—	—	—	—	R	—	—	—	—	—	—	—	—
<i>Fragillaria</i>	P	M	P	P	M	M	M	M	M	F	F	—	—	F
<i>Microcystis</i>	—	—	—	—	—	—	—	—	—	M	M	M	M	F
<i>Mougeotia</i>	—	—	—	—	—	—	—	—	—	—	—	M	—	—
<i>Oscillatoria</i>	—	—	—	—	—	—	—	—	—	—	—	M	—	—
<i>Pleurotaenium</i>	—	—	—	—	—	—	—	—	—	—	—	R	—	—
<i>Pinularia</i>	—	—	—	—	—	—	—	M	M	—	—	—	—	—
<i>Spirogyra</i>	—	—	—	—	—	—	—	—	—	—	—	P	—	—
<i>Staurastrum</i>	F	—	—	—	—	—	—	—	—	—	—	—	—	—
<i>Synedra</i>	—	R	—	R	—	F	F	F	F	R	—	F	—	—
<i>Synura</i>	—	—	—	—	—	—	M	M	M	P	P	M	M	M
<i>Tabellaria</i>	F	M	F	M	F	F	M	M	M	M	M	P	P	M
<i>Ulothrix</i>	—	—	—	—	—	—	—	—	—	—	—	R	—	—

R = Rare

F = Few

M = Many

P = Predominant

the water for the same length of time. For the first measurement, February 8, the bottles were left for a period of 4.5 hours beginning at 1000 hours. March 8, a second measurement was made leaving the bottles for a period of 6.5 hours beginning at 1100 hours, and on the third measurement, March 15, the bottles were removed after 5 hours with the starting time being 0930 hours. On all three sampling dates a separate water sample was removed at the starting time for oxygen content determination at time zero for the productivity tests. At the end of the productivity period, the bottles were immediately fixed for oxygen according to the standard modified Winkler method upon removal from the water.

The sum of oxygen produced in the light bottle and the oxygen consumed in the dark bottle is the total photosynthesis and is listed as the gross primary productivity in units of parts per million (ppm) of oxygen.

Results and Discussion

Physical. Secchi-disc transparency (Fig. 3) is plotted in conjunction with the photronic cell readings which recorded the surface illumination on each sampling date.

A transparency range of 1.7 m to 0.3 m was recorded from January 22 until April 23, 1969. On the first sampling date the apparent color of the water was a transparent brown, which accounts for the Secchi-disc transparency of 1.7 m even though sur-

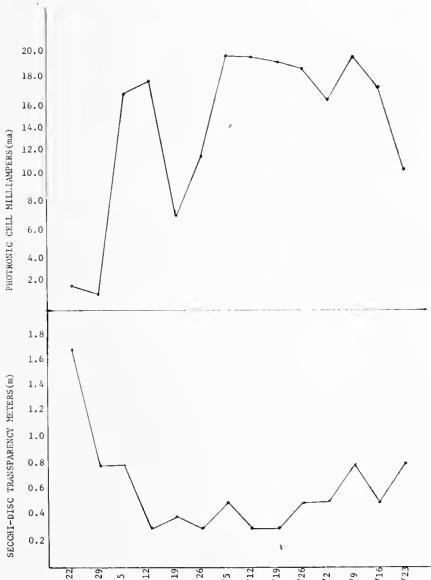


Fig. 3—Secchi-disc transparency and photronic cell readings for each sampling date.

face illumination was low at 2.0 mA. On February 5, transparency was low at 0.8 m, while the photronic cell reading was high at 17.0 mA. The reason for this reading was that the apparent color of the water was a milky-tan due to a heavy load of allochthonous tripton. Allochthonous refers to material being carried into the lake from another source and tripton refers to non-living suspended particulate matter in the water. The tripton was carried into the lake by runoff waters following heavy rains two days prior to sampling.

The tripton persisted throughout the duration of the study always resulting in a milky apparent color of the water. Additions to the tripton load were made by periodic rainfall occurring throughout the study. Because of these milky conditions of the water, the validity of the Secchi-disc transparency, in this study, is of some question. Ruttner (4) pointed out that under this type of water condition, light penetration, due to the scattering effect of the clay, may be deeper than the Secchi-disc indicates. The authors suggest that in this lake the end of the littoral zone or the depth at which rooted aquatic vegetation ceases, may give a truer indication of light penetration.

Of the three depths, surface, 3.0 m, and 5.5 m, at which temperature measurements were made, the surface temperature (Fig. 4) exhibited the greatest range (3.3°C to 17.2°C). Fig. 4 shows no thermal differentiation from the first two sampling dates and again on February 26. The authors believe the in-

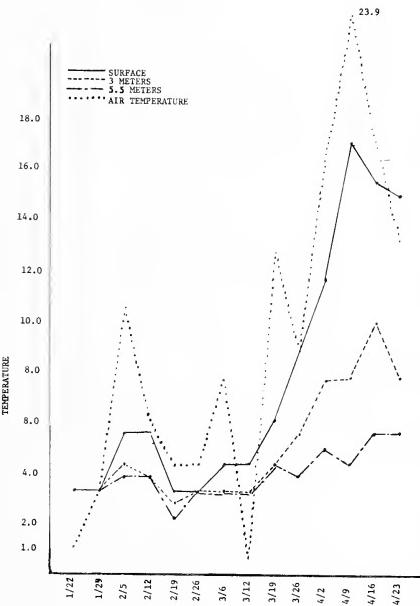


Fig. 4—Winter temperature of Lake Wilcox.

crease in temperature recorded February 5 was due to a combination of three factors: (1) allochthonous clay caused an increased absorbancy of the water; (2) rain water runoff was warmer than the lake water; and (3) increased air temperatures.

A rather sharp decrease in the temperatures of the three depths was noted on February 19, being explained by near freezing air temperatures and heavy rains occurring for four days prior to sampling. From March 26 to the end of the study, the temperatures for the three depth levels sampled became increasingly separated. April 9 showed a temperature difference of 9.4°C between the surface and 3 m, and a 3.4°C difference between 3 m and the benthos or 5.5 m. April 16 recorded a 5.6°C difference between the surface and 3 m and 4.4°C difference for the lower strata. On April 23, the measurements showed a 7.2°C gradient for the surface to 3 m depth and 2.2°C difference between 3 and 5.5 m.

The temperature differences suggest an indication of thermal stratification; however, before a more positive statement can be made, more information is needed concerning the summer conditions of the lake. No such study has been done previously, so there is nothing upon which to base a more positive statement. Boone (6) recorded an average surface temperature of 28°C for his summer study extending from June until August; however, no measurements were recorded below the surface.

Chemical. Oxygen showed little differentiation between depths during the earlier sampling dates (Fig. 5). All three levels recorded in the range of 8.8 to 10.8 ppm until March 26, at which time the dissolved oxygen fell below 10.0 ppm, and with the exception of the surface oxygen, continued to decline to the end of the study. Dissolved oxygen at the 3 m and 5.5 m levels continued to approach anaerobic conditions from March 26 until the end of the study. It should also be noted that the water temperature for these dates and at these levels continued to increase. This fact explains the oxygen drop since the amount of oxygen dissolved in the water is inversely proportional to the temperature of the water (4, 7–10).

Following March 26, surface oxygen increased even though the surface water temperature increased. This was probably due to an increase in the number of phytoplankton present following this date causing an increase in oxygen as a result of their increased photosynthetic activity, the warmer surface waters being more conducive to algal growth and activity (Fig. 9).

Fig. 5 also shows an indication of thermal stratification. The 5.5 m sample was 1.4 ppm or 10% saturated for a temperature of 5.5°C. This depth was approaching anaerobic conditions which, according to Reid (10), is characteristic of the hypolimnion. The authors regard these data as further support for thermal stratification but more information concerning summer conditions is needed.

For the duration of the study, a pH range (Fig. 6) of 6.0 to 7.9 was noted for the surface waters, 5.8 to 7.7 for 3 m, and 5.7 to 7.5 for the benthos. Slightly alkaline conditions existed at all three levels until

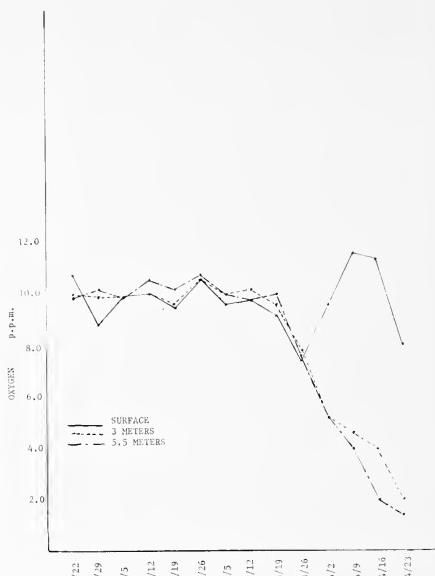


Fig. 5—Dissolved oxygen condition in Lake Wilcox.

March 5, at which time the three levels showed slightly acid conditions.

On April 9, the pH at all three levels recorded the most acid conditions of the study. The following

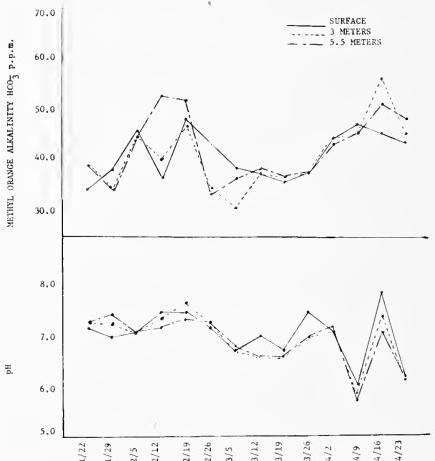


Fig. 6—Hydrogen ion and bicarbonate alkalinity concentration.

sampling date, the pH increased to alkaline conditions with the surface reaching its most alkaline reading of the investigation. The authors are unable to give any definitive explanation for either the pH drop that occurred April 9, or the subsequent increase in pH the following sampling date. Several factors may be responsible for the recorded readings, including some factors that were not included in this study. The decrease in pH to acid conditions could have been a result of the warm temperatures of the water causing an increased activity of the marl precipitators such as *Elodea* sp. and *Chara* sp. According to Ruttner (4) in lakes low in calcium, the calcium carbonate precipitated is not sufficient enough to fix the CO_2 ; therefore, the equilibrium value for the CO_2 being assimilated and the output by respiration is exceeded, and the result is a considerable excess of aggressive CO_2 (the amount of free carbon dioxide exceeding the equilibrium relationship of a bicarbonate solution which is capable of dissolving calcium carbonate), which results in a lowering of the pH.

The authors believe the increase in pH on April 16 may have been a result of the recovery of the aggressive carbon dioxide to normal conditions as well as increased photosynthetic activity by the phytoplankton (Fig. 9) and also the increase in the bicarbonate alkalinity (Fig. 6).

According to Ruttner (4) and Reid (10), Lake Wilcox would be a medium-water lake because the bicarbonate alkalinity (Fig. 6) ranges most often between 35.0 and 50.0 ppm. Fig. 6 shows an increase in the half-bound carbon dioxide, or bicarbonate form of carbon dioxide, for the benthos on February 12, and also on April 16. This occurred on both dates with a concurrent drop in calcium readings (Fig. 7). The calcium being precipitated as calcium carbonate or marl caused a shift in the equilibrium of free CO_2 to the bicarbonate form.

Calcium (Fig. 7) in Lake Wilcox was never found in very large quantities. The graph shows a surface calcium reading of 9.3 ppm for the beginning of the study and 3.6 ppm on the date of termination. According to Welch (7), Reid (10), and Ruttner (4), the calcium readings categorize the lake as a soft-water lake. The recorded drops in calcium are believed to be the result of marl formation causing its loss from the chemical environment in the water. The fact that there is a low amount of calcium in the lake at any time is supported by the fact that the soil associations of the watershed are of the type with a low calcium content, the Atlee-Dunbar Association and Loamy and Gravelly Sediments-Norfolk Association (USDA-Lewis Cullipher). Boone (6) noted a summer calcium range of 14.306 to 16.773 ppm in surface waters of Lake Wilcox.

Surface phosphorus (Fig. 7) ranged from 0.06 to 0.25 ppm; 3 m from 0.06 to 0.23 ppm; and benthic phosphorus from 0.06 to 0.29 ppm. Even though the phosphorus in Lake Wilcox was present in very low quantities, its presence is of considerable importance to the biota. Hutchinson (8) stated that a deficiency of phosphorus is more likely to limit the productivity of any region on the earth's surface than

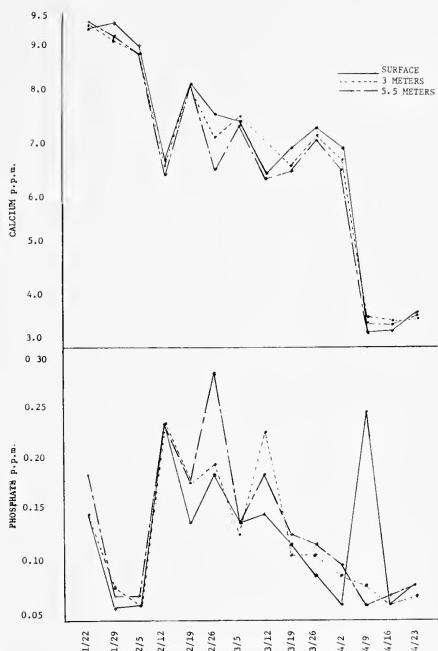


Fig. 7—Phosphate and calcium concentration.

is a deficiency of any other material except water.

Phosphorus showed a decrease on the second sampling date with a substantial increase on February 12. The decrease can, in all probability, be attributed to its uptake by the biota while the increase was probably due to the heavy rains, which preceded this sampling date, carrying phosphate fertilizer from the residential areas into the lake with the runoff water. The gradual decrease in phosphate between February 12 and April 2 was due to its uptake by the biota. Surface phosphate reached its maximum on April 9, and fell to its minimum the following sampling date. In relating this information to other parameters, it was noticed that on April 9, calcium (Fig. 7) fell to its minimum and pH (Fig. 6) shifted to slightly acid conditions. It is doubtful that these two factors alone were responsible for the increase in phosphate. A more reasonable account for the increase is that heavy rains again brought phosphorus into the lake with runoff water and also the warmer water temperatures increased decay processes at the margins of the lake, resulting in the liberation of phosphorus from the decaying organic matter.

It is evident that the rapid decrease in phosphorus on April 16 was due to its incorporation into the systems of the increased numbers of plankton (Fig. 9, 10).

Nitrates (Fig. 8) at the start of the study were low at all the depth levels sampled. An increase in the amount of nitrates was noted until March 5, at which sampling the maximum was reached. This increase, according to Hutchinson (8, 9) was possibly due to the nitrite form of nitrogen being oxidized to give the nitrate form. This process, according to him, lasts from the summer months on into the winter months with no appreciable increase in the quantity of nitrates until the oxidative process exceeds the reductive processes carried on by the phytoplankton. This condition usually only exists when the colder water temperatures cause a decrease in the phytoplankton population and activity. This fact explains the increase in the nitrate quantity to its maximum on March 5. After this date, the nitrates recorded a continuous drop while the phytoplankton (Fig. 9) showed a continuous increase in population.

The authors suggest that the variation of nitrates recorded at the different depths on April 23, is further indication of stratification, but again, more summer information is needed. Boone's surface water showed an inorganic nitrogen range of 0.022 to 0.225 ppm for his summer study (6).

According to Yoshimura's classification of lakes based on their iron content, Lake Wilcox would fall into the second category, as a lake with nearly undetectable iron amounts (11, 12). The iron in the lake ranged from 1.0 to 3.5 ppm (Fig. 8). Accord-

ing to Hutchinson (8, 9), suspended inorganic matter always accounts for some of the measured iron in a lake. Iron in this form is listed as being non-reducible iron because it is not available for plankton usage. The authors believe that the heavy clay load at the time of the investigation accounted for the large majority of the recorded iron because of the oxidized iron present in the well-drained soils composing the watershed, and as a result the iron measurements recorded were insignificant.

Biotic. Fig. 9-11 show the phytoplankton, zooplankton and *Daphnia* sp. recorded for the duration of the study. *Daphnia* sp., because of its size, could not be counted with the rest of the planktonic organisms, but, even though it is graphed separately, it is still considered to be a member of the zooplankton group.

Two factors are demonstrated by the figures showing the analysis of the representative plankton. Both Fig. 9 and 10 show a general increase in the number of different plankters as the study progressed from winter to summer conditions. Both Figures also show the fluctuations in population numbers from one sampling period to the next. For example, during the earlier sampling dates, *Fragillaria* sp. was found in predominant numbers (6+) and during the later sampling dates, it was present in few numbers (2-3).

For the first three sampling dates, all genera of organisms present in a sample were recorded. After a pattern of persistence was developed, those organisms occurring in few or rare quantities on only one or two widely separated sampling dates were not graphed. For the April 16 and 23 sampling dates, again all genera of organisms found in a sample were recorded, regardless of the quantity present because it would not be known whether these organisms persisted as the sampling was terminated on April 23.

It was noticed that on April 16, there was more of a variety of different organisms found in both the phytoplankton and zooplankton samples. It was also on this date that nitrate reached its minimum and phosphate, which reached its maximum the sampling date prior to this, reached its minimum. It was also noticed that during the earlier sampling dates, there was an obviously greater number of zooplankton than phytoplankton. Since this condition persisted until approximately April 12, one might assume that there was some form of organic pollution in the water to allow this unbalanced condition to occur. Mr. M. Culipher (USDA), in a personal conference, related that a Battle Field Park housing development, which lies adjacent to the watershed for Lake Wilcox, contains many private homes with failing septic tanks. These are failing due to impervious soils composing the drainage area for the tanks. He stated that it was possible that a certain amount of the effluent from these tanks was entering the watershed area and being carried into the lake, although the amount would be small due to the great distance from the housing development to the lake.

On January 29, the *Daphnia* sp. were in more of a round form as opposed to being elongated during

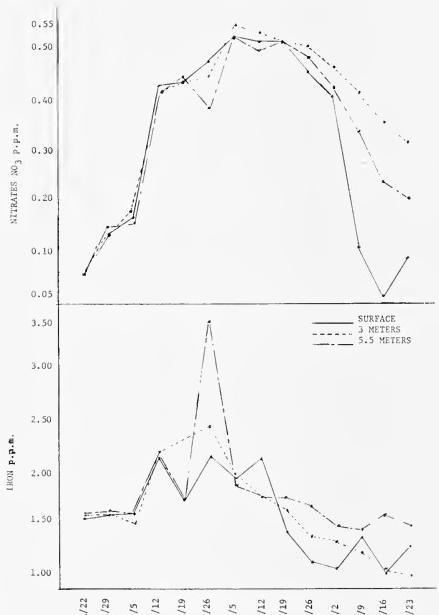


Fig. 8—Iron and nitrate nitrogen concentration.

Predom	A	C	A	A	C	C	C	C	E	C	E	B	G
										E		I	
Many	A	C	C	A		A	A	A	B	B	B	E	B
	B		B	B		E	E	E	B	C	G	F	E
Few	B		B	B	A	B	D	D	A	A	D	K	A
					B	D						F	
Rare	D		D				F	F	D	F	C	L	C
							F	F	F	C	F	M	N
1/22													
1/29													
2/5													
2/12													
2/19													
2/26													
3/5													
3/12													
3/19													
3/26													
4/2													
4/9													
4/16													
4/23													

Rare = 1 per field

Few = 2-3 "

Many = 4-5 "

Predominant = 6+ "

A *Fragillaria*B *Tabellaria*C *Dinobryon*D *Synedra*E *Synura*F *Desmidium*G *Microcystis*H *Euglena*I *Spirogyra*J *Mugeotia*K *Oscillatoria*L *Ulothrix*M *Pleurotaenium*N *Coelosphaerium*

Fig. 9.—Winter population of phytoplankton in Lake Wilcox.

spring conditions toward the end of the investigation. Also, most of them contained eggs throughout the duration of study. On February 5, many eggs of *Daphnia* sp. were seen in the water free from the parent. Other cladocerans found in this sample were egg-laden as well as members of the Rotifera, especially *Keratella* sp. and *Kellicottia* sp. Some egg-carrying cladocerans and egg-carrying rotifers, free eggs and immature forms of each of these were present in the water from January 29 until the terminal sampling date.

On March 12, *Synura* sp. was present in many large elongated colonies. Colonies that were noted prior to this were smaller and round. Also on March 12, *Dinobryon* sp. was seen as large colonies composed of several loricas, while the April 2 sample again recorded *Dinobryon* as being present in predominant numbers, only this time they existed

mostly as single loricas or never more than two loricas per colony.

April 16 showed the greatest variety of phytoplankton of any of the sampling dates. The *Spirogyra* spp. viewed were mostly in the reproductive state with several showing scalariform conjugation and zygospores. The presence of the protozoan *Vorticella* sp. in this sample was probably due to its presence among the filamentous algae that were caught in the net.

Chaoborus sp. and *Chironomus* sp. were the only two benthic animals recorded. *Chaoborus* sp., found in quite constant numbers, averaged 50 organisms per dredge sample for the samples taken. Sporadic sampling in various parts of the lake also recorded the same average. *Chironomus* sp. averaged 5 organisms per dredge sample at the regular sampling station, but sporadic samplings made at various other

ZOOPLANKTON

Predomin.	A G	B G	G	G H	B G H	A	A	A	A	A	A E	A	A	A L R
Many	B C E	C E D	B D B	A D E	D E G	B E F	B E F	B E F	E G G	F G	N	D E O	B E P Q	
Few	D H	A D	A C	D H		B F	I J	C H	C H	B F H J	B D I J	D J M	B G I J M N	C D F G I J K
Rare	F	F I	F I	C I	C I J		C			C D	C	C E I L	R	
	1/22	1/29	2/5	2/12	2/19	2/26	3/5	3/12	3/19	3/26	4/2	4/9	4/16	4/23

Rare = 1 per field

Few = 2-3 "

Many = 4-5 "

Predominant = 6+ "

A Keratella

B Nauplius

C Acanthocystis

D Cyclops

E Bosmina

F Kellicottia

G Sphyriias

H Diaptomus

I Polyarthra

J Synchaeta

K Asplanchna

L Testudinella

M Chonochilooides

N Gastropodus

O Vorticella

P Blepharisma

Q Spirostomum

R Chonochilus

Fig. 10—Winter population of zooplankton in Lake Wilcox.

locations, noted an average of 25 organisms per dredge sample when taken at a 4 m depth approximately 5.0 m from the west bank. Reasons for this were not determined, nor is it known whether this condition existed at other 4 m depths in the lake.

Ruttner (4) pointed out that the presence of *Chironomus* sp. characterizes the oxygen-poor eutrophic type of lake. Also pointed out was that chironomid larvae are never found where the oxidation-reduction potential is greater than 0.4 volts, indicating that in all probability reduction was most likely occurring.

On all three sampling dates for productivity the gross primary productivity recorded was nil. That is

to say there was no oxygen produced in the light bottle and none consumed in the dark bottle. The authors believe that these results were due to the numbers of organisms present causing oxygen production and consumption being too small to be detected with the method used. The February 8 sample was allowed to remain in the water for 4.5 hours, March 8 for 6.5 hours and March 15 was left for 5.0 hours. The readings noted were not necessarily unexpected because they were made while the lake was under winter conditions, when the productivity is known to be low in cold water lakes (5). The authors suggest that different methods of measuring productivity are needed to give more validity to the measurements recorded in this study.

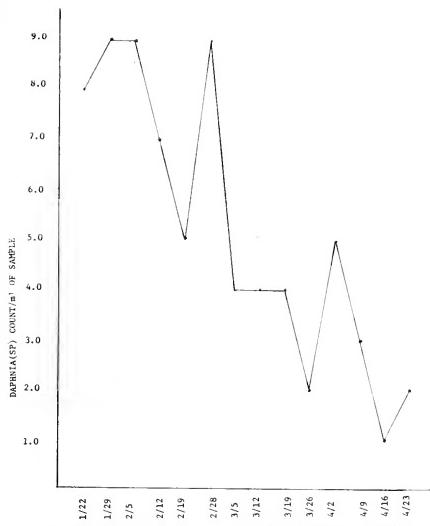


Fig. 11—Winter *Daphnia* sp. population in Lake Wilcox.

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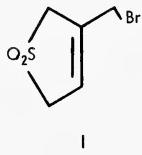
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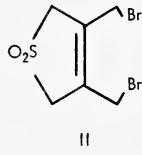
Displacement Reactions of 3-Bromomethyl-2,5-dihydrothiophene-1,1-dioxide and 3,4-Bis(bromomethyl)-2,5-dihydrothiophene-1,1-dioxide

Abstract—Although 3-bromomethyl-2,5-dihydrothiophene-1,1-dioxide and 3,4-bis(bromomethyl)-2,5-dihydrothiophene-1,1-dioxide have allylic bromides their chemical behavior is not typical. They do not undergo solvolysis reactions and only medium strength nucleophiles yield displacement products. Weaker nucleophiles produce no reaction and stronger nucleophiles cause secondary reactions which usually yield insoluble polymers.

In view of the apparent reactive allylic bromides of 3-bromomethyl-2,5-dihydrothiophene-1,1-dioxide (I), prepared by Krug and Yen (1), and 3,4-bis (bromomethyl)-2,5-dihydrothiophene-1,1-dioxide (II), prepared by Butler and Ottenbrite (2), the behavior of these compounds in the presence of certain nucleophilic agents was studied. Krug and Yen (3) have previously conducted a limited study of the monobromide (I) compound, but did not come to any direct conclusion in regard to its reactivity.



I



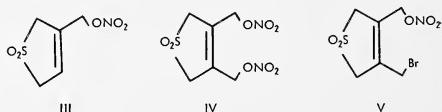
II

Since both of these compounds have allylic bromide atoms, one would expect that these atoms would be very reactive. For example, treatment with ethanolic silver nitrate should produce an immediate precipitate of silver bromide. In both cases, however, a precipitate became evident only after two or three minutes and several hours are required for complete reaction.

Similarly, one would expect these compounds to undergo solvolysis reactions fairly readily as well. However, refluxing compounds I and II in methanol and ethanol for periods of 48 hours resulted in no observable conversion to the corresponding meth-

oxides or ethoxides. Acetolysis was also attempted by refluxing I and II in acetic acid for a 48 hour period without any perceptible reaction. The corresponding methoxide and ethoxides were obtained, however, when an equivalent amount of silver nitrate was added to these solvents.

In general, compounds I and II react readily with silver salts of various nucleophiles. Quantitative yields of the monoacetate from I and the diacetate from II with silver acetate were obtained (4). We have obtained excellent yields of the mononitrate III from I with silver nitrate in acetone. Similarly, very good yields of the 3,4-bis(nitratomethyl) derivative IV, as well as the 3-bromomethyl-4-nitratomethyl derivative V were obtained from II. The latter was



obtained by only using one molar equivalence of silver nitrate instead of two. None of these reactions was instantaneous. Each required three to six hours of reaction time with vigorous stirring at 60° temperatures for completion.

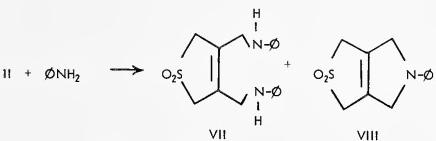
The replacement of bromine by hydroxy groups of an allylic halide is also a well known process. Hydrolysis of I, however, had been attempted by Krug (3) but with unsatisfactory results. We made similar attempts with II and were unable to isolate any distinguishable products. It appears that strong nucleophiles can cause reaction at other sites as well as at the allylic positions. The most likely position, of course, would be the labile hydrogens *alpha* to the sulfur on the thiophene ring.

Further substantiation of this type of reactivity was provided by the attempted formation of VI by the reaction of II with disodium sulfide by the



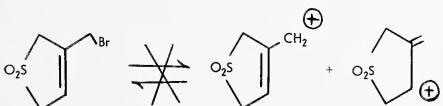
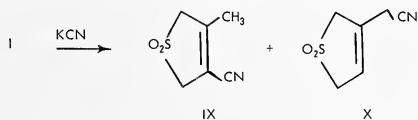
method used by Cava and Deana (5) with α , α' -dibromo- α -xylene. The only product obtained was a light yellowish brown polymeric powder in 85% yield. The material was insoluble; and consequently, was not characterized. Similarly reaction of II with ammonia also produced a polymeric material which was insoluble and not characterized.

Based on the above information, it was felt that weaker nucleophiles were perhaps the most effective for displacement reactions with compounds I and II and that stronger nucleophiles tended to bring about undesirable side reactions and polymerizations. It was found, for example, weakly basic amines reacted quite readily. Aniline derivatives of both I and II were obtained in very good yields (85%). Aniline reacted with II to give two products, the disubstituted product VII (77%) and the cyclic product VIII (23%) which were separated by their difference in solubility in chloroform (6). Similarly, reactions of



I and II with potassium phthalimide gave quantitative yields of the phthalimide adduct. Subsequent hydrolysis of these products, however, with 10% NaOH failed to yield the corresponding amines.

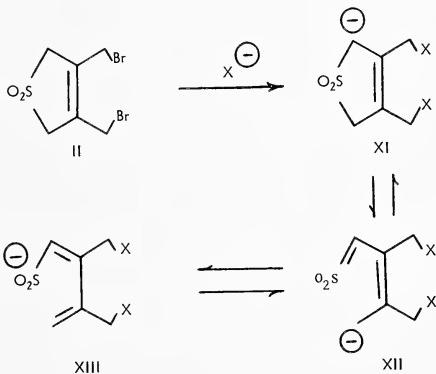
It was reported by Krug and Yen (3) that the conversion of the monobromide I to the nitrile involves a rearrangement process. They refluxed I with potassium cyanide in aqueous ethanol and reported both rearranged product IX and non-rearranged product X. Anionotropic character of the



mesomeric cation from I was proposed based on these results. In our studies we did not observe any rearrangements of this type, and so decided to reinvestigate Krug's findings. The reaction of I with potassium cyanide was carried out as prescribed by these authors. The nmr spectrum of the product showed only three peaks. All were singlets at δ 3.57, δ 3.90 and δ 6.25 in the ratio of 4:2:1. This nmr is clearly indicative of structure X. No other peaks were observed even when the nmr was obtained under high resolution conditions, indicating the absence of any rearranged product, IX.

Thus, it may be concluded that 3-bromomethyl-2,5-dihydrothiophene-1,1-dioxide (I) and 3,4-bis(bromomethyl)-2,5-dihydrothiophene-1,1-dioxide (II) do not appear to undergo conventional allylic type Sn_1 and Sn'_1 reactions. This is based on the evidence that these compounds resist solvolysis reactions unless an accompanying cation such as silver is present to aid in the removal of the bromide. This latter fact seems to indicate that an Sn_2 type reaction is prevalent with a pull effect on the leaving group by the silver ion and a push effect by the attacking nucleophile. Additional evidence for this mechanism is the absence of rearranged products which usually accompanies allylic reactions.

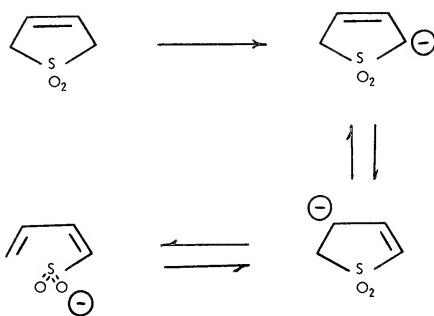
Medium strength nucleophiles, such as amines, however, seem to be strong enough to effect displacement reactions readily on their own. It appears that the strong nucleophiles such as hydroxides or sulfides (X^-) not only react with the allylic bromide but also attack the labile hydrogens *alpha* to the



sulfur to produce an intermediate XI. This intermediate could then undergo ring opening with the formation of XII and XIII which would be extremely reactive and could lead to the polymeric materials experienced from these reactions.

This type of reactivity for the sulfonyl moiety is not novel. It has been reported that in potassium t -butoxide, in dimethyl sulfoxide, 2,5-dihydrothiophene-1,1-dioxide is unstable at 55° and ring open-

ing is observed (7). In the presence of Grignard reagents, these unsaturated cyclic sulfones rearrange to acyclic sulfonylidenes via ring cleavage without elimination of the sulfur dioxide moiety (8).



When compared with the 2,5-dihydrothiophene-1,1-dioxide, compounds I and II seem to require weaker bases and lower temperatures to abstract the labile hydrogen *alpha* to the sulfur since the

electron withdrawing substituents in positions 3 and 4 increase the lability of these hydrogens. This *alpha*-abstraction appears to be the cause of the observed polymer products obtained with the strong nucleophiles. Further investigations are presently being carried out to clarify this process.

Acknowledgment

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A Report of a Cooperative College School Science Marine Biology Project

Introduction

The National Science Foundation, Old Dominion University, the Tidewater Community College, and the public schools of Virginia Beach and Portsmouth cities combined in a joint project to provide advanced training in local Marine Biology for a group of secondary school biology teachers and a research experience for a group of able high school students. The original proposal for the project was developed by Mr. A. B. Niemeyer, Science Supervisor of Portsmouth City and Mr. Don Morgan, Science Supervisor of Virginia Beach in conjunction with Dr. Melvin Pittman, Dean of the School of Science at Old Dominion University. The project has two main purposes: (1) to provide in-depth background in local Marine Biology for high school biology teachers and (2) to provide able and ambitious high school students an opportunity to participate in realistic research type experiences. Financial support for the program became available through the National Science Foundation Cooperative College School Science program.

Description of the Project

Thirty high school biology teachers (15 from each city) were selected to participate in the program. Criteria for selection included: (1) a teaching assignment which included BSCS Green Version Biology, (2) experience in teaching that course, and (3) the recommendation of the Science Supervisor. During the spring semester, the teachers were enrolled in a graduate level Marine Biology course at Old Dominion University. Through a combination of classroom, laboratory, and field trip experiences, their competence in marine science, with special emphasis on the local environment, was increased.

During the summer session, in each city, the group of 15 teachers was joined by approximately 30 high school students from the same city for a six-week research-oriented field course, again under the auspices of Old Dominion. The teachers received graduate credit for the course and the students received a science credit on the high school transcript. The Virginia Beach group used a new high school science department for their base of operations and the Portsmouth City group used the science facilities of the Tidewater Community College Frederick Campus. This report covers the program of the Portsmouth group.

The Frederick Campus of the Tidewater Community College has about two and one half miles of shoreline at the confluence of three rivers (Nansemond, James, and Elizabeth) and the mouth of the harbor of Hampton Roads. The Old Dominion campus is located in an urban area of Norfolk City. Because of the existing cooperation between the two institutions, the science building and facilities of the Frederick campus were made available to the Portsmouth group. The Old Dominion instructor for the Portsmouth group (the writer) had been the Chairman of the Biology Department at the Frederick campus.

The six-week program was organized as follows. The first week involved several field trips around the campus to become familiar with the campus area and the variety of marine situations which were available for study. During this time each participant began to develop the proposed problem for investigation, and these were discussed in group meetings. As a result of common interests or common sites for investigation, the total group divided into eight smaller groups. The original intent of the program had envisioned one teacher and two students as investigation teams. However, the resultant groupings which evolved from common interests seemed to be more satisfactory. Table I lists the groups and the individual investigations undertaken within each group.

TABLE I

<i>A List of Investigations Undertaken in the Program</i>
A Preliminary Survey of the Macrofauna and Flora Found in a <i>Spartina alterniflora</i> Community. (Three separate communities in different environments involving four teachers and four students)
A Comparative Study of Two Ecotones. (Two teachers and two students)
A Preliminary Survey of the Floral and Faunal Composition of the Streete's Creek Estuarine Community. (Two teachers and three students)
An Investigation of Energy Flow: Intertidal Logs. (Two students)
Zonation Patterns on an Intertidal Rock. (One teacher and one student)
An Ecological Study of the Numbers, Sizes and Distributions of <i>Balanus balanoides</i> on Pilings. (One teacher)
Preliminary Examination and Classification of Sediments Collected at Tidewater Community College, Pig Point, Virginia. (One teacher and one student)

- A Preliminary Determination by Isolation and Identification of Bacterial Species Present in Waters off Pig Point, Virginia. (One teacher and three students)
- Epiflora and Epifauna of *Callinectes sapidus* Captured at Two Different Locations. (Two teachers and two students)
- Population Distribution Studies of Selected Species in Artificial Tidal Pools. (Two students under the direction of a teacher)
- An Investigation of the Distribution and Rhythmic Behavior of the Blue Crab in Streeter's Creek. (One teacher and three students)
- A Study of the Endozoic Organisms found in Selected Lake Fish. (One student)
- A Study of the Patterns of Chemical Concentrations in the Water at Streeter's Creek. (One student)
- A Study of the Floristic Patterns of Two Ecotones. (One student)
- An Investigation of the Amount of Energy Stored by the *Spartina alterniflora* Beds. (One student)

The middle four weeks of the project were concerned with the conduct of the investigations. During this time visiting lecturers addressed the group, describing their own current research, field trips to other marine environments were scheduled, and each of the participating teachers presented a one-hour lesson on some aspect of marine science for the benefit of the participating students. This was usually accomplished during the first hour of the five-hour day.

The final week of the project was devoted to preparation and presentation of the papers describing the investigations conducted. Several visitors from the Portsmouth school system and Old Dominion attended the presentation of the papers. The facilities of both the Tidewater Community College and Old Dominion libraries were utilized by the participants in developing the investigations.

Evaluation of the Project

Evaluation of the teacher participants was based on two aspects of their performance: (1) caliber of their own research investigation during the project and (2) their effectiveness in working with (i.e. teaching) the student participants in their group. The students were evaluated primarily on the basis of their own investigations. At the end of the project, all participants completed an anonymous evaluation of the program.

From the writer's viewpoint the most effective evaluation of the project will become available during the ensuing school year. If the teachers use the knowledge and skills they developed during the project to improve their biology teaching, if they encourage new students to undertake investigations and projects involving the local marine environment, and if they continue their own research projects, the program will have accomplished its objectives with respect to the teachers involved. If the student participants continue their investigations, if they enter local and state science fairs, and if they continue in their concern for the conservation of the local marine environment, the program will have achieved its objectives for them.

Some Thoughts of Possible Interest to Science Educators Considering Establishing a Similar Program

In retrospect, the most important aspect of the program to both the participating teachers and students was the opportunity to become involved in research type activities. Careful planning is necessary in order to insure that appropriate equipment and materials, library reference books and journals, and physical facilities are available or can be obtained. The teacher participants must be research oriented so that the students learn "the scientific methods" as they design and carry out their investigations. The use of local scientists as visiting lecturers early in the program can help participants understand both the need for good experimental design and the many possible frustrations that can occur. Possibly the greatest benefit to the instructor occurs as participants (both students and teachers) openly evidence the joy they are experiencing as they investigate nature directly.

Because of the mutual agreement of the desirability and success of the project, present plans are to expand the program and include teachers and students from other neighboring school systems.

ALAN MANDELL

*School of Education
Old Dominion University
Norfolk, Virginia*

TEACHERS!!

Do you have a question that you'd like answered? Do you have a favorite demonstration, method of getting across a concept, or an experiment that you'd like to share with others?

Do you have a technical article that you'd like to have published?

Are you involved in a program, a course of study, or an activity which you think would be of interest to other educators?

Would you like to analyze or give a critical evaluation of a curriculum, talk, article, or book?

Would you like to do a little philosophizing?

GREAT NEWS—NOW IS YOUR CHANCE!!

The editor of the Virginia Journal of Science plans to devote a page or two in each issue to items written especially for junior and senior high school teachers of science and mathematics. We are now soliciting contributions which will be of interest to teachers and which will be of value in furthering scientific and mathematical education in the state.

Send your contributions to Virginia C. Ellett, Mathematics and Science Center, 2200 Mountain Road, Glen Allen, Virginia 23060. Do this right away so that they may appear in the next issue of the Journal, but don't stop here. Let this be the beginning of many articles from you. Remember this is YOUR section and its success depends upon your contributions.

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News and Notes

MRS. DU PONT MOURNED

Mrs. Alfred I. du Pont (Jessie G. Ball du Pont), long a patron of the Virginia Academy of Science, died at the age of 86 at her home near Wilmington, Delaware, September 26, 1970. She was born at Ditchley in Northumberland County and was a graduate of Longwood College. Before her marriage, Mrs. du Pont taught in Virginia and California.

In addition to the Virginia Academy of Science, Mrs. du Pont was a benefactor of a number of educational institutions in Virginia, particularly Washington and Lee University and Hollins College. The chapel at Hollins College was named in her honor and she received an honorary doctor of laws degree from the College of William and Mary. She was the first woman appointed to the board of Washington and Lee and the first woman to receive the Virginia State Chamber of Commerce's distinguished service award for service to the state and to education. She was a founder and vice president of the Virginia Museum of Fine Arts, a trustee of Hollins College, member of the Virginia Foundation for Independent Colleges and assistant treasurer of the Robert E. Lee Memorial Foundation.

Mrs. du Pont owned Ditchley estate at Ditchley, her birthplace in Northumberland County, Virginia, and also maintained a home in Jacksonville, Florida.

NEW SCIENCE BUILDING

Mary Baldwin students this fall began classes in the college's new \$2 million Jesse Cleveland Pearce Science Center on the campus in Staunton. The Science Center, for the first time, houses under one roof facilities for biology, chemistry, physics and psychology thus increasing opportunities for interdisciplinary studies. One floor and part of another are assigned to the biology department. Special features include a controlled environment suite with walk-in warm and cold temperature units and plant growth chambers in which light, temperature and relative humidity can be controlled. A greenhouse-animal room annex houses animals for botany and psychology classes, a unit for growing plants for study and research, and a display area for local and exotic plants. Special research laboratories equipped for individual experimentation make it possible for a student to pursue independent studies. There are similar laboratories for faculty members engaged in research.

The multi-purpose James D. Francis Auditorium seats 260 persons and will be used for science lecture sections and lectures by visiting scholars. The auditorium is equipped with three permanent backdrops which are controlled electronically. The backdrops include chalkboards, a hardwood surface which can be lowered and a translucent screen to be used for rear projection of films and theater backdrops.

The Center is named for a distinguished physician, Dr. Jesse Cleveland Pearce, who practiced in Graniteville, S. C., for more than 50 years. Public dedica-

tion of the facility took place Saturday, October 3, on Founders' Day. The main speaker for the dedication ceremonies was Dr. Hans M. Mark, director of the Ames Research Center of the National Aeronautics and Space Administration in California. The previous evening Dr. Jeannette R. Picard showed films and spoke about her experiences on her stratospheric balloon flight in 1934.

ANIMAL RESEARCH FACILITY

The Medical College of Virginia, Health Sciences Division of Virginia Commonwealth University, opened its new "farm" for research animals in September, 1970. It is situated on 89 acres of land in Hanover County, 9 miles north of Richmond near the Lewistown exit of Interstate 95. Preliminary plans for the rural facility for larger animals, and for animals to be observed for long periods of time, began in 1968. Construction started in October, 1969 and was completed in August, 1970. The total cost of \$396,350 was supported by state funds, institutional funds and a grant from the National Institutes of Health.

The main building contains two surgical suites, two laboratories, supply room, office, conference room and autopsy room. Three wings extend from this building for housing and care of animals. The larger wing is for isolation, quarantine, and holding of dogs. It includes a receiving room, a dip and cleaning room, office for veterinarian and examining room, as well as 50 pens for dogs. The other two wings each have facilities for animals on long term experiments; there are 26 pens in each wing. Each pen is equipped with a feeder, automatic water device and elevated resting area. Outside run areas are available on these two wings. All areas meet or exceed federal regulations for size, light, air circulation, and temperature control.

The barn is designed for sheep, goats, hogs or cattle. All animal areas are washed daily. Refuse and water drains to a fenced sewage lagoon. This was constructed to standards set by the State Water Control Board and will not cause pollution to streams, rivers or air. No human waste goes into the lagoon.

A resident manager lives in a house on the grounds and a veterinarian is available at all times on call and regularly spends a number of hours each week at the institution.

The animal facilities of the Medical College of Virginia are accredited by the American Association for Laboratory Animal Science. It is one of 146 institutions accredited out of a possible 6,000. Purchase, quarantining, husbandry, and veterinary care of all laboratory animals used in the teaching and research programs of the institution are licensed under the requirements of the U. S. Department of Agriculture and the animal facilities are inspected monthly by this federal agency.

VCU BUILDING NAMED FOR DR. HARRY LYONS

The Board of Visitors of Virginia Commonwealth University has named the new \$4 million addition to the School of Dentistry in honor of Dr. Harry Lyons. The new dental education facility, to be known as the Lyons Building, is located at the Medical College of Virginia, the Health Sciences Division of VCU. Dr. Lyons, dean of the MCV School of Dentistry for nearly 20 years, retired on July 1, 1970, after 47 years on the faculty. He is a 1923 graduate of the MCV School of Dentistry and is known nationally for his contributions to dentistry and dental education. He is a past president of the American Dental Association, the American Academy of Periodontology, and the Virginia State Dental Association, and has been a member of the Virginia Academy of Science for many years.

The new four-story addition gives the School of Dentistry 130 per cent more floor space with 105 dental operating areas equipped with modern high-speed equipment. It is the only dental education facility in the United States that uses closed circuit color television as a daily teaching aid in dental instruction. The Lyons Building has enabled the School of Dentistry to expand its entering class from 80 to 100 students and to extend its research and post-graduate training programs and continuing education offerings for Virginia dentists. The MCV/VCU School of Dentistry is the only dental school in Virginia and currently enrolls 342 students in a four-year program.

VISITING SCIENTISTS PROGRAM

Dr. Alexander M. Clarke, associate professor of biophysics at the Medical College of Virginia, Health Sciences Division of Virginia Commonwealth University, has been named Director of the Virginia Academy of Science Visiting Scientists Program. His address is Box 877, MCV Station, Richmond, Virginia 23219; Telephone 770-4041.

Introduction to Physical Organic Chemistry

By RICHARD GILLIOM

Addison-Wesley Pub. Co.

Reading, Mass., 1970

332 pages, \$10.95

This textbook presents an elementary introduction to some of the principles encountered in physical organic chemistry as a third semester undergraduate course. Basic topics covered are molecular orbital theory, chemical kinetics and linear free energy relationships. These principles are then applied in more detail in regard to nucleophilic substitution and aromatic substitution reactions and mechanisms.

In general, the undergraduate third semester or-

ganic course entails reaction mechanisms and synthetic methods. However, most up-to-date sophomore organic courses presently place a considerable amount of emphasis on basic principles of reaction mechanisms and synthesis. Consequently, advanced organic courses are often repetitive. This reviewer has always been in favor of a physical organic approach to this type of course. It develops a student's ability to think chemistry through deductive reasoning based on physical principles and experimental data. "Introduction to Physical Organic Chemistry" is a step in this direction. It is the first book of its kind that presents this approach to the undergraduate level.

The material in chapters 1 through 3 is written as a general review of atomic and molecular theory which is available in greater depth in the average physical chemistry textbook. It is felt that the author could have used this space to present a more functional and practical approach to molecular orbital calculations than is presented in chapters 4 and 5. Chemical kinetics is discussed in chapters 6 and 7, and a general review is given. It is felt again that this material is repetitive from a physical chemistry course and perhaps more applications of the theory to organic chemical systems would be more pertinent. The author's treatment of linear free energy relationships, in chapter 9, is very well done. He treats the Hammett equation and related functions in reasonable depth. Chapter 10, for the most part, is a review of freshman and physical chemistry acid-base theory. More effort could have been spent on acidity functions and related material. The author's consideration of methods of reaction mechanisms is good. He could have expanded this section considerably, which would have given the student a broader picture of the techniques. The last two chapters dealing with electrophilic and nucleophilic substitution reactions are very well written. The topics discussed in the previous chapters are incorporated in the treatment of these two topics.

This book, however, does not cover several topics which this reviewer feels essential in this area. Among these are more concise applications of thermodynamics, photochemistry and solvolysis. Perhaps the author could have expanded some of the areas so that the book could have had some value as a reference text rather than being so course-oriented.

The author does write in a clear, lucid manner which makes it easy for the student to follow and comprehend. He also incorporates excellent problems at the end of each chapter as well as a bibliography of pertinent reference material. The author's style is also characterized by his ability to give appropriate scientists credit for their contributions in the areas discussed.

It is the opinion of this reviewer that this textbook has a very good format for an undergraduate level course. The lecturer can handle the topics in many ways as well as add or delete sections.

RAPHAEL M. OTTENBRITE

General Notice To Contributors

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All articles should be typewritten (double-spaced) and submitted on good bond paper ($8\frac{1}{2} \times 11$ inches) in triplicate to the Editor. Margins should not be less than $1\frac{1}{4}$ inches on any border. Title, running title, authors, place of origin, abstract, figures, legends, tables, footnotes, and references should be on individual pages separate from the text. Technical abbreviations should follow consistent standard practices with careful avoidance of unnecessary neologistic devices. All pages (including illustrations) should be consecutively numbered in the upper right corner. A pencil notation of author names on the back of each page is helpful in identification.

Illustrations should be supplied in a form suitable for the printer with attention to the fact that a reduction in size may be necessary.

A good technical article generally contains an obligatory abstract before the text, an introduction, with reference to preliminary publications that may exist, an experimental section, results (which may be included in the experimental section), a discus-

sion, and conclusion. References are indicated in the body of the article by consecutively used numbers in parentheses. Although publication costs are high, attention should be given to relatively complete references (bibliographies) since the purpose of an article is to illuminate the significance of present and past findings, and not merely to obscure the past. The Journal reserves the right (generally exercised) to make page charges for articles in excess of 5 pages and to bill authors at cost for unusually complicated illustrative material.

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2. Chappell, J. B., Cohn, M., and Greville, G. D., in B. Chance (Editor), *Energy linked functions of mitochondria*, Academic Press, Inc., New York, 1963, p. 219.
3. Riley, G. A., and Haynes, R. C., Jr., *J. biol. Chem.*, **238**, 1563 (1963).

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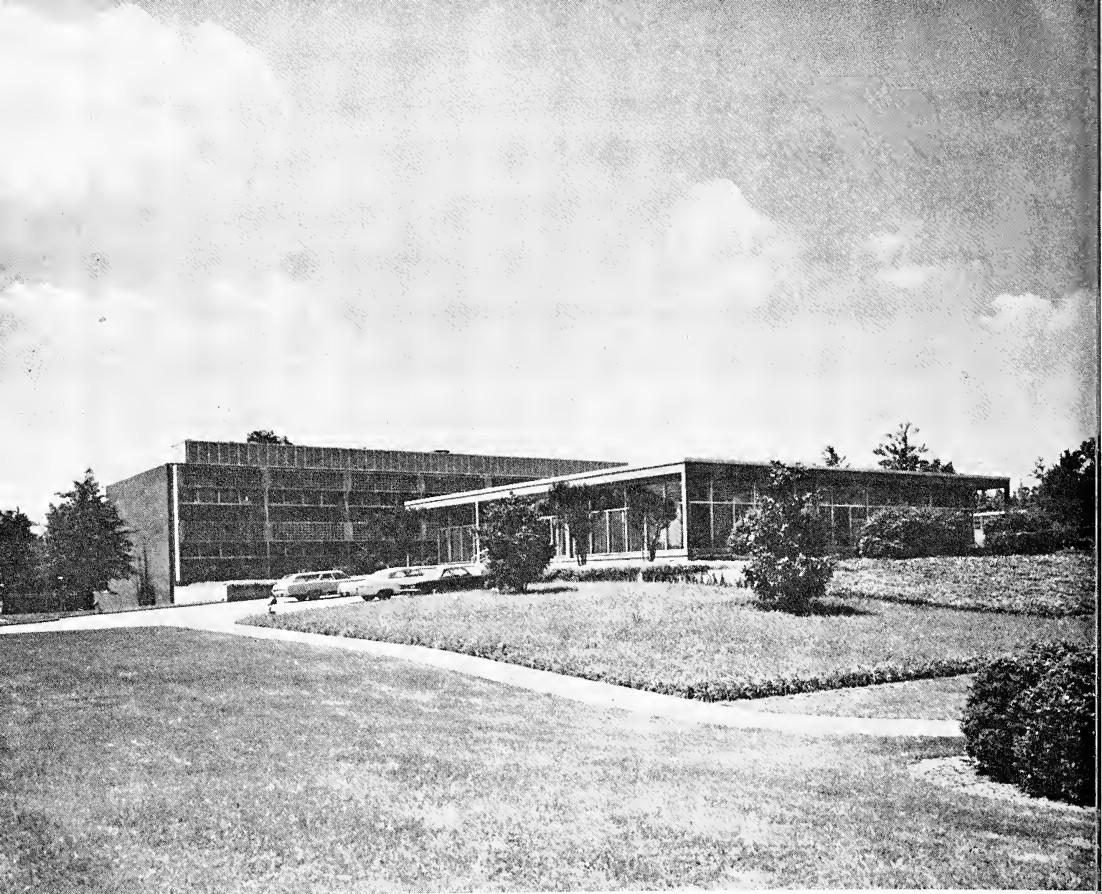
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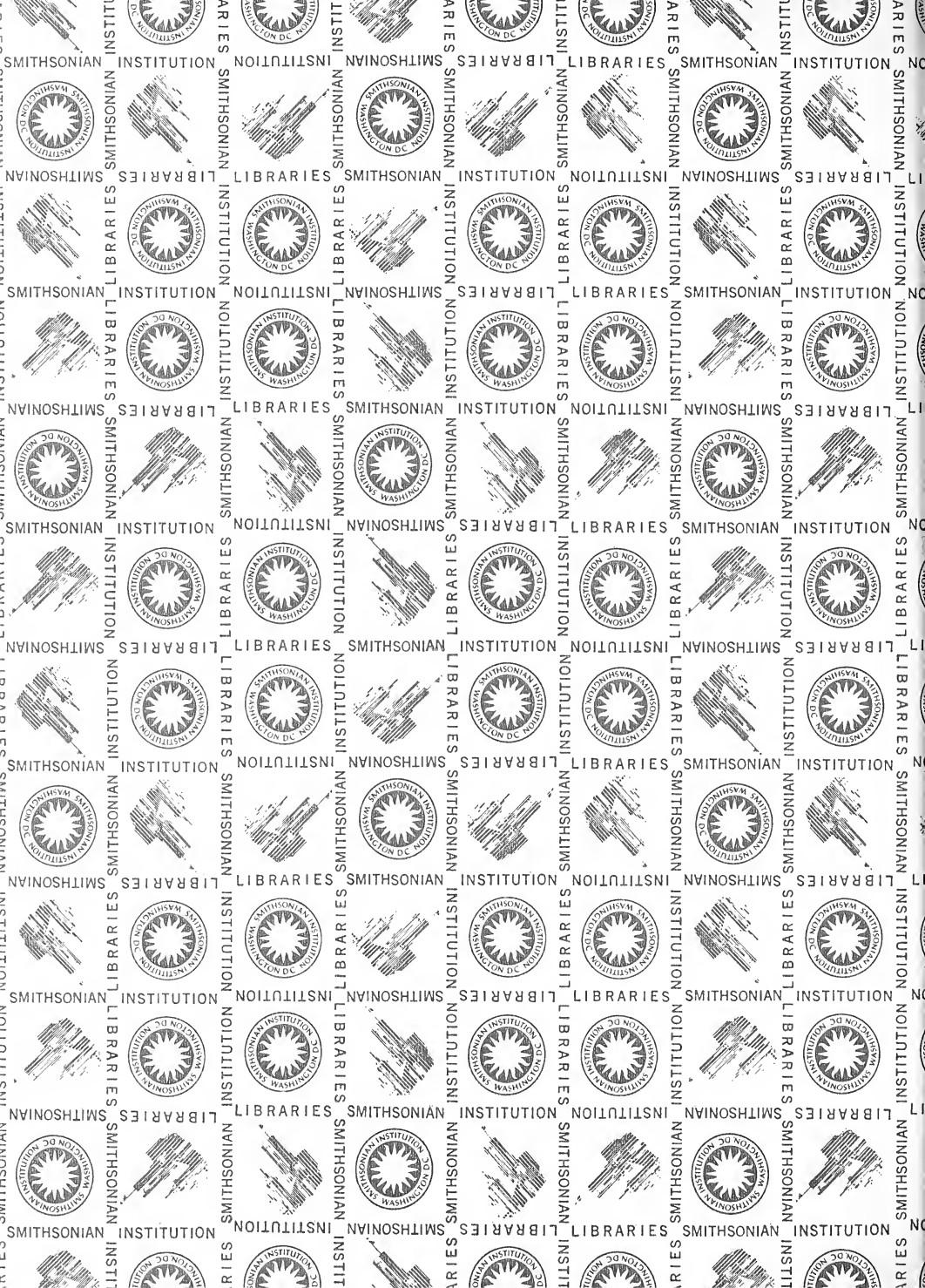
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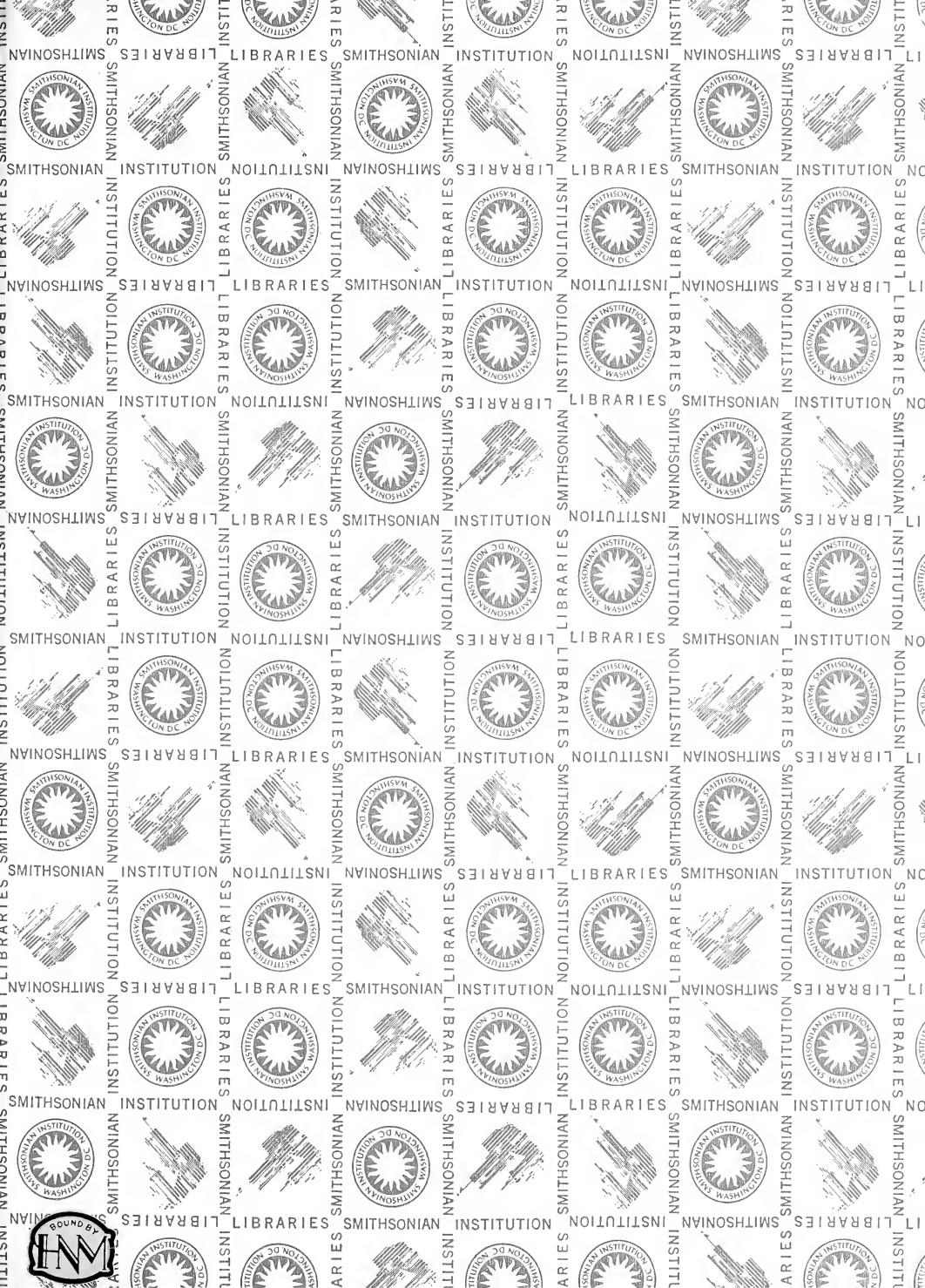
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